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Research Article

Power quality improvement in solar energy conversion system

M. Miruna, A. Nandhini, A. Sownthariya*, B. Subhashree, K. Yadhari

Department of Electrical and Electronics Engineering,
Knowledge Institute of Technology, Salem, Tamilnadu, India.

*Corresponding author's e-mail: sownthariyaasok@gmail.com

Abstract

This research work presents a generalized control algorithm for power quality (PQ) amelioration of the grid in presence of nonlinear load. The proposed method alleviates the voltage imbalance, a power electronic interface is suggested between the source and the load whose function is to provide output voltage regulation and also improve power quality. Maximum power point tracking (MPPT) technique is employed to identify the peak power point and extract peak power from the PV by utilizing a boost convertor. As the inverter in the solar power photovoltaic (PV) feed into the terminal, the output voltage from the inverter needs to be controlled to meet in the AC circuits. The photovoltaic system using proposed control technique is validated under voltage sag-swell, distorted and load removal conditions and the results are displayed. The main aim of the project is to reduce the losses during transaction between the systems and obtain high efficiency.

Keywords: Maximum power point tracking; Power quality; Sag swell; Boost converter; Efficiency.

Introduction

An electric power system can be said to be reliable if it meets the criteria for quality and continuity of its power distribution. Distribution of electrical energy is the most frequent problem due to many factors [1]. The proposed technique is used in the presence of steady state, voltage sag, voltage swell, load removal, unbalancing and distorted grid voltages conditions [2]. Electricity is a primary need for society. Electricity consumption is the main motto in the past, because of its abundant availability with the capacity to do work [3].

Over time, now is the time when people are required to save electricity. Some factors such as loss in the distribution system, theft, inefficiency in billing, and commercial losses are the main reasons behind the loss [5]. The loss line is the result of current passing through imperfect conductors such as copper.

Causes of Voltage Drop on Feeders the voltage drop on electrical feeders depends basically on two parameters; these are; the impedance of the feeders and the current flowing through the feeders [6]. This study proposes an adaptive second order generalized integrator based quadrature signal generator-frequency locked loop (SOGI-QSG-FLL) and fuzzy tuned proportional integral (FPI) in grid interconnection of photovoltaic (PV) system with shunt power quality conditioner (SAPF) for quality of power enhancement [8]. This problem is one of the problems in the electricity distribution system. Optimizing conductors is one of the most important steps in planning and optimizing distribution networks [9]. This study aims to analyze the voltage drop in the transmission line and provide an alternative limitation of the problem of voltage drop using the solar power [10].

Existing system

In the existing system, electrical energy is generated using a solar PV array. The generated voltage is supplied to the boost convertor. In the boost convertor the voltage is boosted to a high voltage value. The generated DC voltage is converted to AC voltage using inverter. Inverter is connected with a PWM controller. The PWM controller modulates the pulse of the converted AC voltage, When the pulse matches the DC voltage is converted to phase voltage. The voltage is connected to a load. On connecting the

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load there occurs a voltage drop. Voltage drop is the decrease of electrical potential along the path of current flowing in the circuit. In this case the need voltage rate is not provided to the load this decreases the efficiency of the system. In this case the harmonics of the system is monitored.

The decrease in voltage causes distortion in harmonics. The harmonic distortion are measured and rectified. On applying nonlinear loads these kinds of losses takes place. To obtain the maximum peak output harmonics are eliminated. Harmonics cause damage to transformers and lower efficiencies due to the voltage drop. These losses can become significant (from 16.6% to 21.6%) which can have a dramatic effect on the HVAC systems that are controlling the temperatures of the building where the transformer and drive equipment reside. Active harmonic filters cancel harmonics by dynamically injecting inverted (180o out of phase) current into the AC line, improving electrical system stability. Generally, an active harmonic filter is installed on the ac lines in parallel to the loads that produce the offending harmonics. Thus after eliminating the harmonics in the power system the system attains the maximum power point value.

Proposed system

P&O (Perturb and Observe) Method applied in MPPT algorithm which is used to track the maximum power even under variable environmental condition and also it minimizes the solar power fluctuation. In boost converter side, flyback type converter was used. Flyback has an advantage of high efficiency and isolation between input and output. PIC micro controller always measures the grid voltage and current based on the requirement the renewable power was injected into the grid. Fig. 1 shows the block diagram of proposed work. This type of compensation also known as Dynamic Voltage Restorer (DVR). Load resistance is used to limit the grid voltage.

Hardware used

Solar panel

A solar panel is actually a collection of solar (or photovoltaic) cells, which can be used to generate electricity through photovoltaic effect. These cells are arranged in a grid-like pattern on the surface of solar panels. Thus, it may also be described as a set of photovoltaic modules, mounted on a structure supporting it. A photovoltaic (PV) module is a packaged and connected assembly of 6×10 solar cells. Fig. 2 shows the solar panel. These days, solar panels are used in wide-ranging electronic equipment's like calculators, which work as long as sunlight is available.

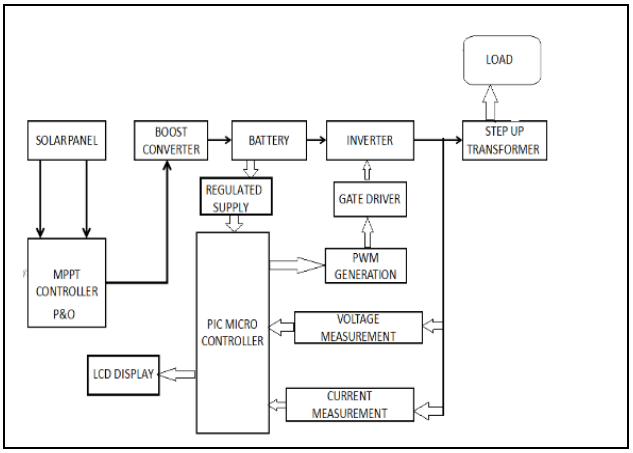

Fig. 1. Block diagram of proposed system

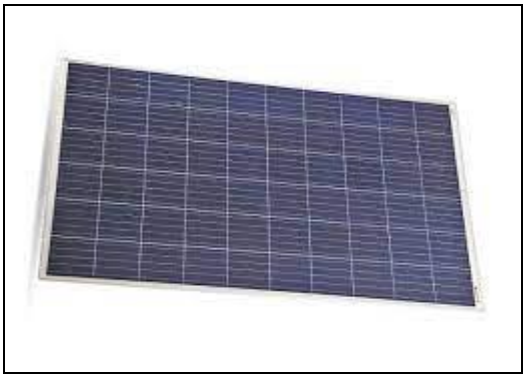

Fig. 2. Solar panel

MPPT controller

Maximum Power Point Tracking, frequently referred to as MPPT, is an electronic system that operates the Photovoltaic (PV) modules in a manner that allows the modules to produce all the power they are capable of. MPPT is not a mechanical tracking system that "physically moves" the modules to make them point more directly at the sun. MPPT is a fully electronic system that varies the electrical operating point of the modules so that the modules are able to deliver maximum available power. Additional power harvested from the modules is then made available as increased battery charge current. MPPT can be used in conjunction with a mechanical tracking system, but the two systems are completely different.

The conventional controller simply connects the module to the battery and therefore forces the module to operate at 12V. By forcing the 75W module to operate at 12V the conventional controller artificially limits power production to 53W. Fig. 3 shows the MPPT Controller.

Fig. 3. MPPT Controller

Boost controller

A boost converter (step-up converter) is a power converter with an output DC voltage greater than its input DC voltage. It is a class of switching mode power supply (SMPS) containing at least two semi-conductor's switches (a diode and a transistor) and at least one energy storage element. Filters made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce output voltage ripple. A boost converter is sometimes called a step-up converter since it "steps up" the source voltage. Since power (P = VI) must be conserved, the output current is lower than the source current. Fig. 4 shows the BOOST Controller.

Fig. 4. BOOST Controller

The boost converter has the same components as the buck converter, but this converter produces an output voltage greater than the source. "Boost" converters start their voltage conversion with a current flowing through the inductor (switch is closed). Then they close the switch leaving the current no other path to go than through a diode (functions as one way valve).

Battery

A lead-acid storage battery is an electrochemical device that produces voltage and delivers electrical current. The battery is the primary "source" of electrical energy used in vehicles today. It's important to remember that a battery does not store electricity, but rather it stores a series of chemicals, and through a chemical process electricity is produced. Basically, two different types of lead in an acid mixture react to produce an electrical pressure called voltage. This electrochemical reaction changes chemical energy to electrical energy and is the basis for all automotive batteries.

Fig. 5. Batteries - Primary or Secondary

Batteries can either be a primary cell and it is shown in fig. 5, such as a flashlight battery once used, throw it away, or a secondary cell, such as a car battery (when the charge is gone, it can be recharged).

PRIMARY CELL: Because the chemical reaction totally destroys one of the metals after a period of time, primary cells cannot be recharged. Small batteries such as flashlight and radio batteries are primary cells.

Stepup transformer

A transformer is a static device that transfers electrical energy from one circuit to another

through inductively coupled conductors—the transformer's coils. A varying current in the first or primary winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic field through the secondary winding. This varying magnetic field induces a varying electromotive force (EMF) or "voltage" in the secondary winding. This effect is called mutual induction. Fig. 6 shows Step up Transformer

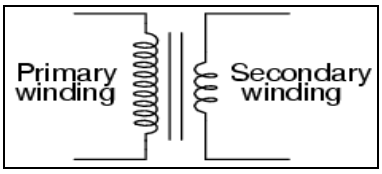

Fig. 6. Stepup transformer

The transformer has made long-distance transmission of electric power a practical reality, as AC voltage can be “stepped up” and current “stepped down” for reduced wire resistance power losses along power lines connecting generating stations with loads. At either end (both the generator and at the loads), voltage levels are reduced by transformers for safer operation and less expensive equipment. A transformer that increases voltage from primary to secondary (more secondary winding turns than primary winding turns) is called a step-up transformer.

PIC MICROCONTROLLER (PIC 16F877A)

PIC is a family of modified Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to "Peripheral Interface Controller". PIN diagram of PIC Microcontroller is shown in the fig. 7.

PICs are popular with both industrial developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flashmemory) capability. Fig. 8 shows the PIC Microcontroller.

There are three memory blocks in the PIC16F87XA device. The data memory is partitioned into multiple banks which contain the general purpose registers and the Special Function Registers (SFRs). Bits RP1 and RP0 are the bank select bits.

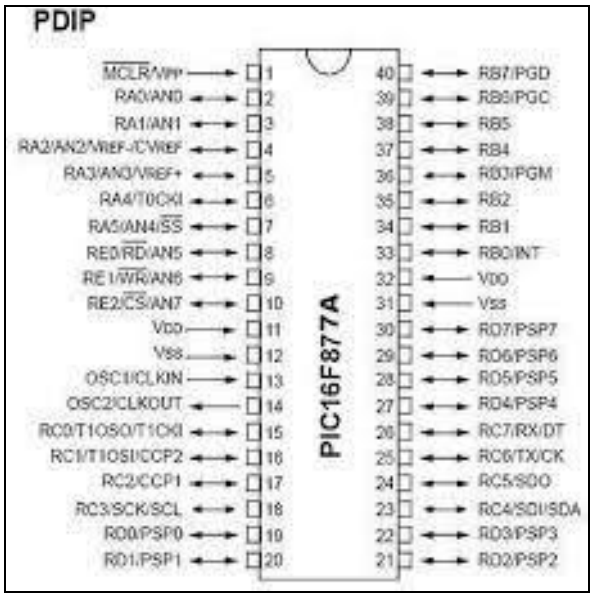

Fig. 7. PIN diagram of PIC Microcontroller

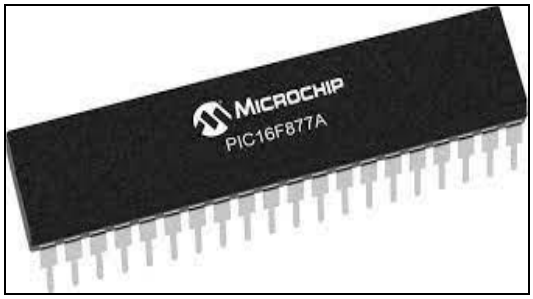

Fig. 8. PIC Microcontroller

Software used

MPLAB is a proprietary freeware integrated development environment for the development of embedded applications on PIC and ds PIC microcontrollers, and is developed by Microchip Technology. MPLAB X supports automatic code generation with the MPLAB Code Configurator and the MPLAB Harmony Configurator plugins. MPLAB® X Integrated Development Environment (IDE) is an expandable, highly configurable software program that incorporates powerful tools to help you discover, configure, develop, debug and qualify embedded designs for most of Microchip’s microcontrollers and digital signal controllers. MPLAB X IDE works seamlessly with the MPLAB development ecosystem of software and tools.

Conclusions

The Voltage regulation topology along with power quality improvement is considered and implemented experimental setup for solar

conversation system. All other methods are implementation for low power and lesser level of mild topology. The results are shown effectiveness of the proposed control technique by extracting the Voltage in the grid under various conditions. It proposed controller is executed on No load condition without loss, On Connecting the Motor gets decreased, so it switched to boost and voltage gets increased.

Conflicts of interest

Authors declare no conflict of interest.

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