Harmonic Filtering in PV connected AC loads

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Abstract

It is a known fact the power crisis has literally crippled many nations and slowed them down from keeping up with the technological reforms in every field in order to solve he power issue, different renewable energy system are being analyzed and implemented that can be contributed to the power shortage. Since most of the industrial and residential electrical equipment using AC power to operate, these renewable energy systems must have a converter to transform DC power to AC power in attempt of doing, the system is subjected to high frequency harmonics due to converters, which can be degrade system performance. This research intends to find out an effective solution to reduce the high frequency harmonics by designing and implementing filters in solar cell driven AC loads.

Keywords: Harmonics, AC loads, Filters, Renewable Energy, Frequency, and Solar PV.

I. Introduction

Sources of renewable energy i.e geothermal, solar and wind have acquired acceptance due to the attenuation of conventional energy sources. Several (DG) systems make use of renewable energy sources and are being designed and connected to a grid. Solar energy is an the important renewable energy system that is being adopted as alternative power source all around the world [I] [II].

In the beginning, solar cells were used for small and medium sized applications. Later on in 1980, the first commercial solar power plant was deployed after realizing the fact that solar energy is inexpensive and is capable of handling commercial loads. After the advent of renewable energy sources, the solar cells are today one of the widely used electric power generators [III]. The applications of solar cells in today world are countless. Even though solar cells do have some limitations, but still they
provide good solution to the power crises that has been a major issue for the past few years [IV].

Using renewable energy sources, such as solar cells, does not only contribute to the power needs but can also provide a clean and eco friendly way to fulfill our power needs. Other alternatives to conventional energy sources such as fossil fuel engine electricity generator is being used to generate electricity are also used as backup power systems and even on commercial levels in oil rich countries. These fossil fuel generators can pose serious threat to the environment and are also responsible for the depletion of fossil fuels. Solar cells thus provide an excellent solution to all the aforementioned issues and can work in both standalone and collaborative mode [V] [VI].

One of the major areas of research that has attracted many researchers in connecting the PV solar generators with grid, the PV generators can contributes to the grid and shares the load by supplying necessary power to it. Another important thing to consider when connected solar cells with the grid are the fact that the power produce by it is the D.C. Since most of the equipment's work on AC power, it is necessary to convert the power produce by AC cells to entertain AC loads even when connecting it to the grid the converters are required [VII] [VIII].

There are many types of power electronics converters depending upon the nature of application and requirements. This research does not focus on the type of converters but rather driving AC loads using solar cells. In fact, power converters are going to be a part of this research but not the major area of concentration. A DC to AC converter is necessary to drive AC loads using solar cells. With the advancement of technology these converters can convert power efficiently and able to controlled using different types of controllers [IX] [X].

When driving an AC load using DC generator, a converter is necessary. The major parts of the converter used in such a system consist of a controller and other devices that contribute in efficient and proper flow of power from source to the load. One of the major issue that is faced while using power electronic converter is the generation of harmonics. The converter use in power system operated on high frequencies for DC to AC conversion. These harmonics are responsible for degrading system performance and reduce its efficiency. This research focuses on reducing these harmonics by introducing filters. It reduces the harmonics and total harmonic distortion in the system. The power generated by renewable energy system can be utilized efficiently [XI].

II. Objective of Research

The ultimate objective is to analyze different filters and modify them to control the harmonics generated by the converter used in solar cells. In order to
achieve the intended goal of this research, first a system has to be designed using a circuit simulator that can replicate the actual scenario of AC load being driven by a DC source, which in this case would be a solar cell. The system would have different components such as the power converter, AC load, transformers, control system for the converter etc. To complete this research within the designated period, following sequential milestones must be attained. Choosing an appropriate power converter that has been or is mostly used for DC to AC conversion.

Designing a system that consists of a solar cell, a power converter and an AC load in detail to analyze the harmonics nature of harmonics generated in the system. Designing a harmonic filter to reduce the harmonics and concluding how it affects the performance of the system. The block diagram of the system is shown in Figure.1.

![Figure 1. Block Diagram](image)

III. Methodology

In order to achieve the structured objectives and milestones described previously and efficient and flexible methodology would be adopted to see the effect of the proposed scheme as shown in Figure.2.

Gathering relevant data from the authentic sources regarding the AC load connected to DC sources and different topologies used for DC to AC converters.

As shown in Block diagram, The solar panel is source of generating DC power which is next deliver to power inverter to convert it to AC with help of controller. A harmonic filter is then reduce the unwanted harmonic frequencies as these harmonics reduce the efficiency of AC power which was generated in power inverter during DC to AC conversion, from harmonic filter then the filter AC power is finally deliver to the AC load.
The last would be to take appropriate measures to enhance power transfer of the system and reduce harmonics by implementing different harmonic reduction techniques literature review.

Figure 2. Overall Methodology

IV. Conclusion:

Since power crisis is one of the very critical issue going on in today’s world, the major contribution of this research is customized to power generation and power quality improvement. The in-depth analysis of PV power generators and enhancing the quality of the converters by implementing different topologies in power electronics is the key to overcome many issues and a promising technique to provide clean energy in an easy yet efficient way.

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