Improved Passive Power Filter performance for renewable power generation systems

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Abstract : Both electric utilities and end users of electric power are becoming increasingly concerned about the quality of electric power. It is an umbrella concept for a multitude of individual types of power system disturbances. One such major concern is the harmonics which is made the focus of study in this work. When electronic power converters first became commonplace in the late 1970s, many utility engineers became quite concerned about the ability of the power system to accommodate the harmonic distortion. Harmonics problems counter many of the conventional rules of power system design and operation that consider only the fundamental frequency. Therefore, the engineer is faced with unfamiliar phenomena that require unfamiliar tools to analyze and unfamiliar equipment to solve. This thesis is basically concerned with the Analysis and Mitigation of Harmonics generated by Power Electronic Converters. MATLAB/SIMULINK has been employed for presenting the simulation results because it is well established and recognized simulation software for the power system. Next, the designing of Passive Filter is carried out after a literature review and have been applied to the converters for harmonics mitigation. In the future, we would proceed to work on Active Filters for Harmonics Mitigation. One of such problem is generation of current and voltage harmonics causing distortion of load waveform, voltage fluctuation, voltage dip, heating of equipment etc. Also presence of non-linear loads such as UPS, SMPS, speed drives etc. causes the generation of current harmonics in power system. They draw reactive power components of current from the AC mains, hence causing disturbance in supply current waveform. Thus to avoid the consequences of harmonics we have to compensate the harmonic component in power utility system.

Keywords: Direct current, Alternating Current, Silicon Controlled Rectifier, Insulated Gate Bipolar Transistor, Metal Oxide Semiconductor Field Effect Transistor,Active Power Filter

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I. INTRODUCTION

Renewable energy has been an important component of India"s energy planning. The importance of renewable energy sources in the transition to a sustainable energy base was recognized in the early 1970s. Modern renewable energy is being used increasingly in four distinct markets: power generation, heating and cooling, transport, and rural/off-grid energy services. The Ministry of New and Renewable Energy (MNRE) in India has been facilitating the implementation of broad spectrum programs including harnessing renewable power, renewable energy for rural areas for lighting, cooking and motive power, use of renewable energy in urban, industrial and commercial applications and development of alternate fuels and applications.

In addition, it supports research, design and development of new and renewable energy technologies, products and services. The approach for deployment of new and renewable energy systems focused on a mix of subsidy, fiscal incentives, preferential tariffs, market mechanism and affirmative action such as renewable purchase obligations by way of legislation and policies. Financial support has also been extended to research and development (R&D), information & publicity and other support programs. Renewable energy plays an important role in the long-term energy supply security, diversification of energy mix, energy access, environmental security and sustainability.

Renewable energy is bound to play an increasing role in future energy systems. This chapter analyses central level policies and interventions for renewable energy applications and also recommends a set of guidelines to serve as a roadmap to accelerate the deployment of renewable energy technologies.

Motivation:

The main motive is to suppress harmonics and reactive power compensation. Both active power filters and passive filters have their own advantages. The best way is to use both in a grid connected system at point of common coupling. So hybrid filter is best choice for power quality improvement. Conventionally, passive filters consisting of tuned L-C filters have been used to suppress harmonics because of their low initial cost. However, passive filters suffer with drawbacks such as large size, parallel and series resonance that could be created with both load and utility impedances. These drawbacks of passive filters, active power filters (APF) were developed. APF are power electronic converter based devices that are used for power quality improvement.

II. RELATED WORK

Different techniques are found in the literature on power quality improvement in distribution systems. Satyanarayana et al. [1] studied hybrid fuzzy controlled Improved Power Quality Conditioner (IPQC) to have an active filter and found that to be useful under different loads. Bouzid et al. [2] studied different ways of controlling power distribution with respect to micro grid applications. It is also suitable for renewable energy sources. They studied inner control loops for Distributed Power Generation Systems (DPGS). Georgilakis [3] proposed an Optimal Distributed Generation Placement (ODGP) to bestow best sizes and locations of DGs in order to improve the quality of power distribution systems. Li et al. [4] investigated on the reduction of DG

control complexity by proposing a control method and ensure that quality of power is enhanced. They employed current controller and adaptive hybrid voltage to achieve this. Zhong and Hornik [5] proposed a control strategy known as cascaded current-voltage control to enhance power quality in the presence of local load.
Rahmani et al. [6] studied two different approaches for enhancing power quality and combined them. They are known as Thyristor-controlled reactor and shunt hybrid power filter. In other words, it combines an active power filter and also a passive power filter. Acuna et al. [7] investigated the usage of voltage source inverter along with an active filter technology. They also used a control scheme known as predictive control scheme for enhancing performance for renewable PG systems. Susila and Rajathy [8] on the other hand proposed a hybrid active filter for improving power quality. Singh and Baredar [9] also used a filter based approach known as shunt active power filter for analysing power quality for renewable energy source. Srivatsava et al. [10] studied different filters to get rid of harmonic components in power distribution. Camacho et al. [11] focused on safety and power quality with respect to a reference generator with different injected currents. It employs both active and reactive strategies.

III. SYSTEM DESIGN

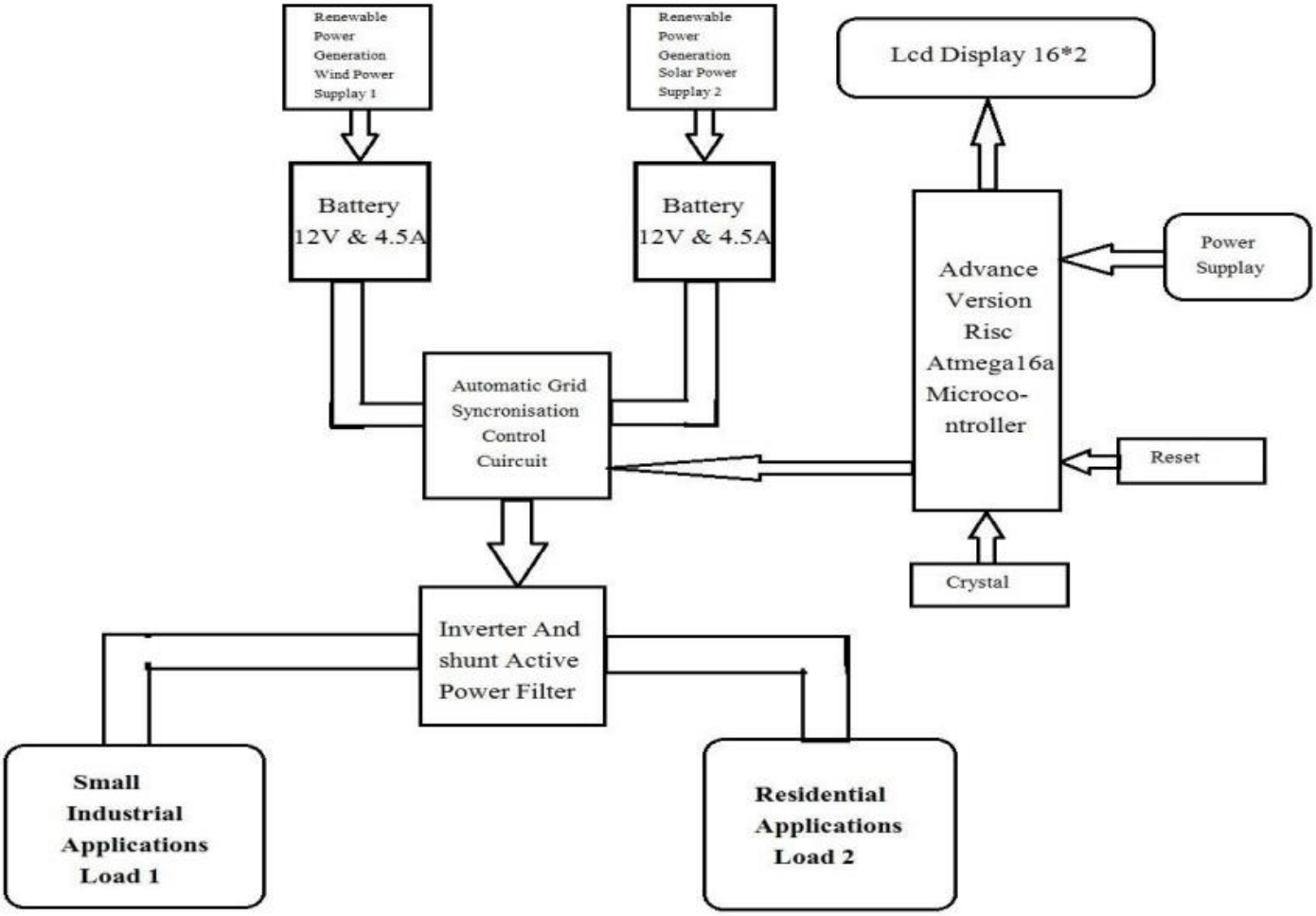

Figure3.1 Block diagram of improve passive power filter using renewable energy sources

In above figure shows two types of power generation systems, i.e. Wind and Solar from renewable power generation system. By using passive power filter, Efficiency of electric power is improved also harmonic reduction and power quality improve is done. The power emitted from wind and solar is stored in battery. If the Ac motor is used in wind then the output is received in Ac and same for the Dc motor. In Battery only Dc current is stored after that diode is used, which converts Ac into pulsating dc voltage. Capacitor is used for Pure Dc which does filtering of harmonics. In this system there are two types of supply generation but, this system works only one type of generation system, for which grid synchronization needs to be done through DPDT (Double pole double throw) relay. With The help of DPDT relay Grid synchronization system is carried out. In case, if the solar power is discharge then the wind connections cannot be changed manually for that Automatic DC Grid synchronization system is necessary. This is called Distribution system. Then Both power generation system current and voltage value of battery are 4.5Amp and 12Volt respectively. The voltage required for industrial appliances is 230volt. But, the batteries have voltage 12volt so transformer is used to meet the required voltage i.e. 230volt. Capacity of voltage and current is increased by using harmonic reduction. Inductor is used to increase the voltage from 12v to 230v AC. The inductor blocks DC voltage and passes AC voltage. To increase the voltage MOS-FET is used, which does switching of positive and negative values which occurs in both the generation due to this frequency is formed, as Ac components works on frequency.

In this system, two loads are used as application i.e. industrial and commercial. Controlling circuitry is formed for both generation system i.e. AVR . Two types of switches are use, if the supply of solar is over, then the supply can be converted on wind system with the help of controlling circuit. The main motto behind the use of this system is that power consumption can be done.

IV. SIMULATION RESULT

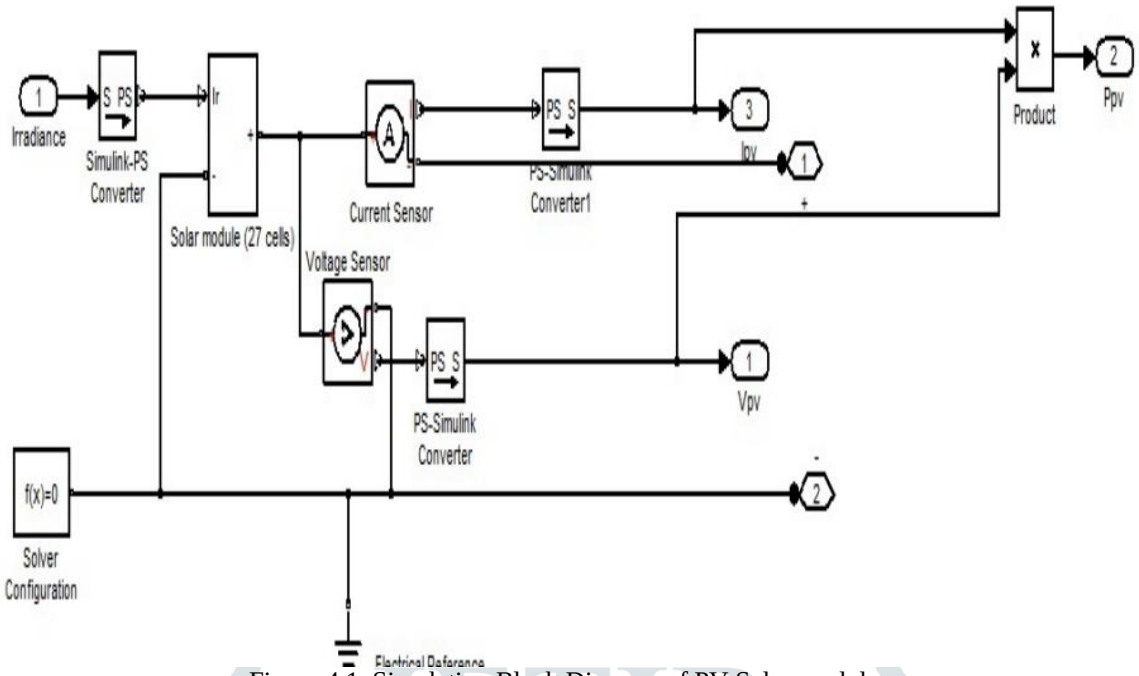

Figure 4.1. Simulation Block Diagram of PV Solar module

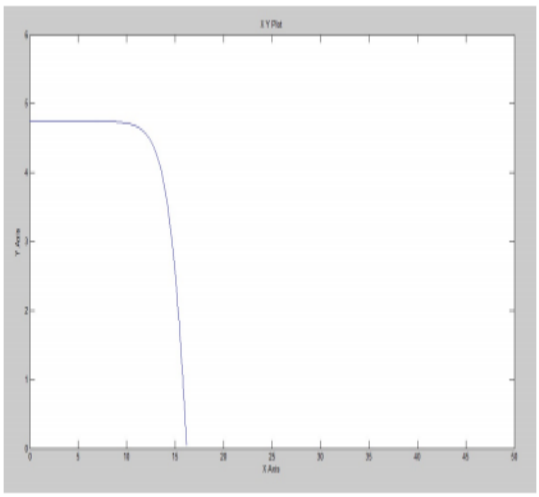

Figure 4.2 solar dynamics output in Simulink of V-I graph

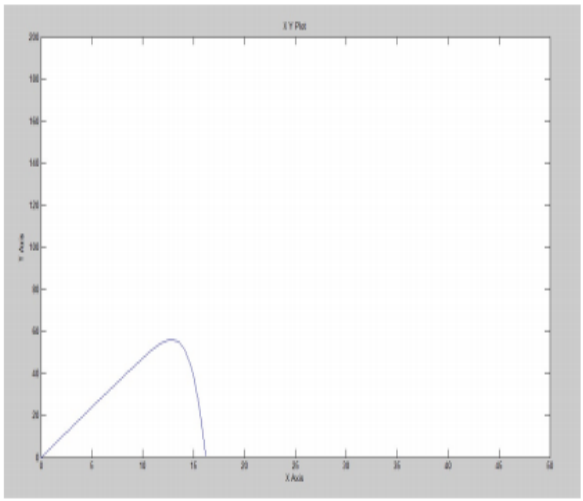

Figure 4.3 Solar dynamics output in Simulink of P-V graph

V. CONCLUSION

Thus passive harmonic filters are an effective, easy and economical option to counter the issue of harmonics arising in small and large scale power systems or networks involving non-linear loads. However passive filters suffer from the following shortcomings.

- More number of filters is required for mitigating more harmonic orders. This might increase the initial capital cost.
- They are characterized by sharp resonant operating points which might sometimes cause damage to the apparatus.
- Flexibility in control cannot be achieved using passive filters but on the contrary power systems are dynamic in nature and hence there is a need for flexible and automated control.

But nevertheless passive filters are always looked upon as a viable choice from economical point of view. They are also found to be effective when the system is affected by specific order harmonics to a great extent. A description of various methods proposed by researchers to achieve different 61 combination of goals like harmonic elimination, reactive power compensation, unity power factor has been presented. With the aim to rectify polluted supply current, the current harmonics introduced by the shunt AF commit counter-phase to the current harmonics produced by the load. The control approach involves the generation of reference current, that must be provided by the Active Filter to compensate reactive power and harmonic currents claimed by the load.

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