Impact Of Single Tuned Filter on Grid Connected PV System

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ABSTRACT

A grid-connected photovoltaic power system, or grid-connected PV power system is an electricity generating solar PV system that is connected to the utility grid. Its impact on power quality of the system is major concern for both utility company and users but that quality may be affected by harmonics. Therefore Reducing harmonic content in the grid connected power system is very important. In this paper , effect of single tuned harmonic filter on grid connected PV system is analyzed. Its impact on harmonics and power factor is considered. For simulation study PV connected system of Dr. C.V. Raman university, Kota is considered .For simulation study ETAP software is used. The system parameters are taken from actual site condition.

Keywords- PV Solar, Harmonic, power quality, LV distribution system, harmonic filter.

INTRODUCTION

The power quality of electrical power systems has a severe influence on control and utilization of power. Electrical power systems behave like nonlinear loads, creating a deformed waveform that is made up of voltage and current harmonics. Voltage and current harmonics created by these nonlinear loads cause on the distribution systems and other electrical segments. It is therefore essential to evaluate the complete effect of these harmonics problems such as increasing power losses, degrading the conductors, and as a result have negative effect on the distribution systems and other electrical segments. It is therefore essential to evaluate the complete effect of these harmonics. The sum total of the various harmonics present in a system is called Total Harmonic Distortion (THD). THD gives the opportunity to evaluate the extent of distortion in a system.

Total Harmonic Distortion (THD) is the common used index to indicate the level harmonic distortion the THD can be calculated using

$$THD = \frac{\sqrt{\sum_{2}^{\infty} F_i^2}}{F_1}$$

Where F_i is the amplitude of i^{th} harmonic, and F1 is for fundamental component[3].

Individual frequency components are aggregated based on rms calculation as shown in below equation

$$F_{n,vs} = \sqrt[2]{\frac{1}{15}\sum_{i=1}^{15} F_{n,i}^2}$$

Where F represent voltage (V) and current (I) in rms value represent the harmonic order, I is a simple counter [4].

METHODOLOGY

Single line diagram of PV connected distribution system of Dr. C.V. Raman University is shown in figure 1. At present distribution system is supplied from 315kVA, 11000/415V Grid connected Transformer, 10kW solar panel is also grid connected through 415 V system at Bus 5. Simulation is done by using ETAP software.

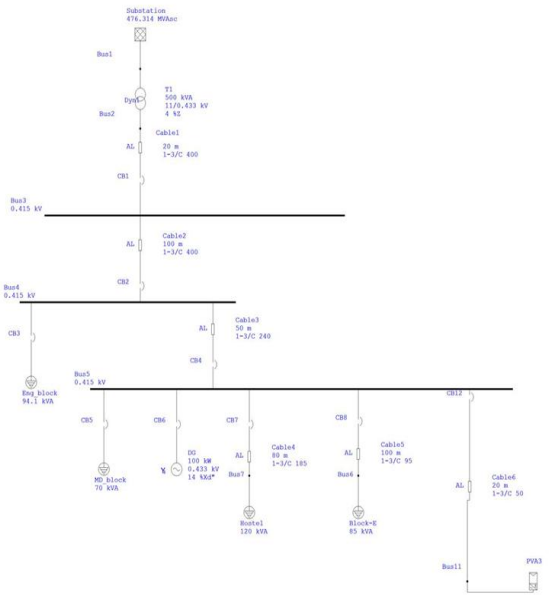


Fig.1 Distribution system single line diagram of Dr.C.V .Raman University

Total Harmonic Distortion analysis is performed for the single line diagram as shown in figure.1 and it is found that the THD at bus3, bus 4 and bus5 is 4.91%, 4.38% and 4.23% respectively. To reduce this harmonic content in the system use of single tuned harmonic filter is considered.

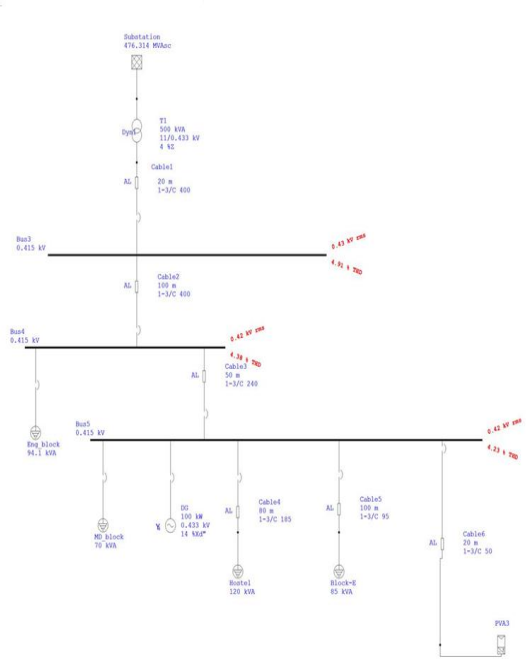
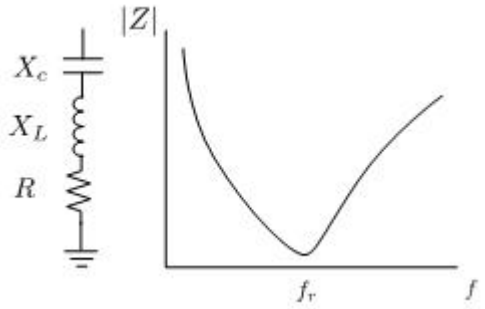


Fig.2 THD analysis of 10kW Grid connected PV solar system

The objective of this research is to analyze the effect of single tuned harmonic filter on the harmonics for PV Integrated system in order to avoid exceeding harmonic limits therefore the future problem that will arise due to the large integration of grid connected PV solar system can be avoid during initial planning. [6,9]. In order to reduce the harmonic content , single tuned harmonic filter is considered and simulated and connected at bus 3 via a circuit breaker. Single tuned harmonics Filter can be designed for any particular harmonics to eliminate. To design the single tuned harmonics filter, its different parameters(capacitance, inductance, resistance) must be set to eliminate a particular harmonic frequency.



Single tuned filter

$$C = \frac{Q_c}{2\pi f V^2} \qquad X = \frac{1}{2\pi f h C} = \sqrt{\frac{L}{C}}$$

$$L = \frac{X}{2hf} \qquad Q = \frac{2\pi f L}{R} \qquad R = \frac{1}{2\pi f C}$$

Existing power factor is approx 90% and desired power factor is 97%. To reduce say, 10th order harmonic component harmonic frequency would be 500 Hz and all the parameters are set according to this harmonic frequency. . C = 2.2 millifarade, inductive reactance =0.01 ohms ,resistance= 0.15ohms. These data are fed to ETAP software and the simulation results are shown as follows

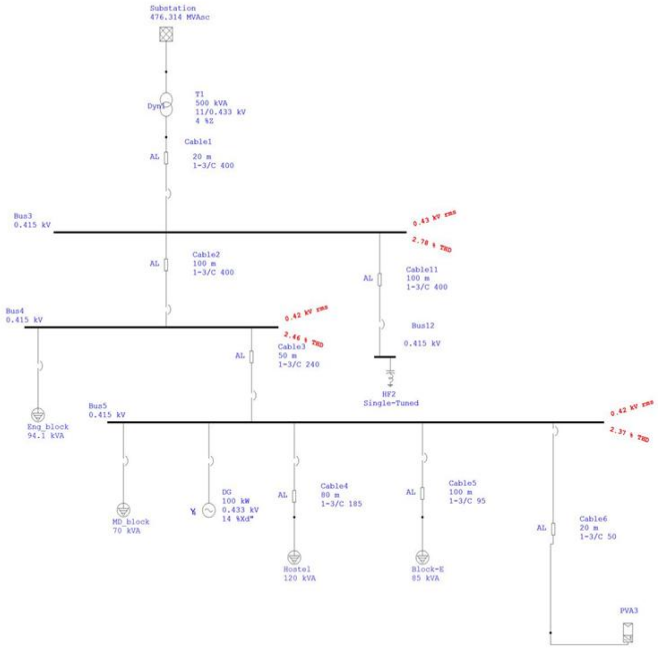


Fig..4 THD for single tuned harmonic filter connected to grid connected PV system

RESULT

From above analysis, THD is analyzed for single tuned harmonic filter designed to eliminate 10th order harmonic in grid connected PV system.

SINGLE TUNED FILTER	THD at BUS 3	THD at BUS 4	THD at BUS 5
WITHOUT FILTER	4.91%	4.38%	4.23%
WITH FILTER	2.78%	2.46%	2.37%

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Thus by considering single tuned filter for grid connected PV system THD is within IEC standard.

CONCLUSION

THD analysis of LV grid connected PV System is done for single tuned filter. Harmonics decreases when it was set to eliminate specific order of harmonics and are within IEC standard. As harmonics decreases, power quality of the system improves. Desired power factor can also be achieved by using these harmonic filters. Thus By using these filters power factor correction is also performed. Therefore it is required to have a proper study of PV Grid connected power system. The analysis from such studies will help to manage harmonic of the PV connected power system.

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