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Modeling and Simulation of Grid Connected PV System

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ABSTRACT

In today's scenario, renewable energy based applications are increasing due to the global warming issue and increase in the prices of fossil fuels. Renewable energy sources (RES) like sun, biomass, air, water etc. are environmental friendly and have plenty of potential that can be utilized in power generation. However, RES have a problem of intermittent in nature that can be conquered presently by combining RES known as hybrid system that can provide the reliable, economic and environment friendly electricity. The increased penetration of grid-connected renewable energy sources has an impact on the grid power quality in particular weak grids. Voltage fluctuation, frequency fluctuation and harmonics are major power quality issues.

KEYWORDS: *Solar cells, MPPT, STATCOM, Active power, Reactive Power*

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1. INTRODUCTION

Demand of energy increases day by day and to meet energy demand we are shifting towards renewable source like solar system, wind energy, tidal energy, bio gas energy etc. renewable energy are easily available on earth hence it attract interest of researcher. At the large scale renewable energy generation, power quality into the grid is important parameter .to improve power quality of grid we need shunt reactor to compensate reactive VAR. in this paper we are designing a micro grid (solar system with grid). In my proposal there are 10KW load connected to micro grid, nearly 50% load shared by solar cell and rest of load will share grid .My focused in this paper is reactive power compensation and Maximum penetration in grid by PV cell. As we compensate the reactive power PF will improve and power quality of solar grid system also improves. This paper deal with the generation of energy combine which lead to generating electric supply with the minimum cost without damaging nature. This paper deal with the generation of energy which lead to generating electric supply with the minimum cost without damaging nature [1]. When light energy is changed into electrical energy, it is called solar power generation. Many units and panels are connected electrically in parallel-series combination to produce the required power. By using the result of photoelectric effects, the light is directly changed into electric current[2]. Depending upon the light transferred per unit area, the Photovoltaic range generates direct current. With the help of inverter or universal bridge, the dc power is being converted into ac power having phase and frequency. In my thesis, eight photoelectric modules are being used.. The quality and electrical behavior is determined on light and temperature. The maximum boundary of solar flow is 1000 W/m^2[3]. The circuit diagram is shown in Fig-1

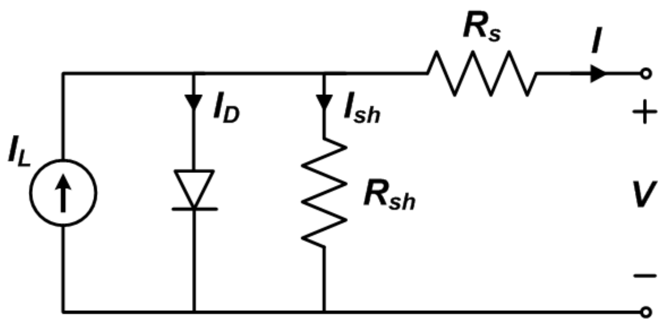

Fig. 1 Equivalent circuit diagram of PV system with series and parallel resistance

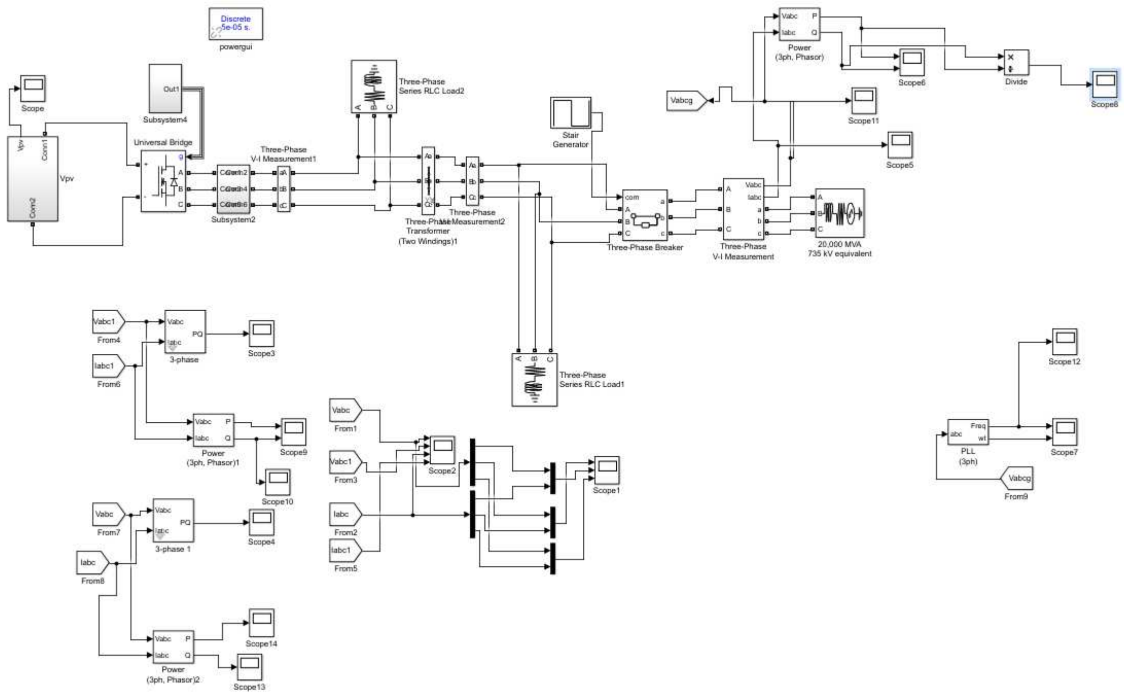

Fig- 2 MATLAB/ simulink of grid connected PV system

2. Effect on nature:

In hybrid system we are using SPV with grid no other source used in the paper. This paper present the generation of energy which lead to generation electric energy with minimum cost without damaging nature. Because SPV generation technology reduce the CO_2 emission by replacing fuels in power generation in industry and transportation [4].

Life cycle CO_2 emission is much lower than fossil fuels. The life cycle balance also consider to be important factor in the best generation and transportation [5].

Based on analysis done by IEA, RNPG same 1.7 Gt of CO_2 emission in 2008.

According to IEA analysis BRICS country will same CO_2 emission roughly 5.3 Gt in year 2030 by using RNES[6].

For decrease in total CO_2 emission if use SPS at the place of thermal power plant for same power output can be calculated for n year.

$$\text{Same in } CO_2 = \sum_1^n E_t N_t \alpha_t \beta_t \quad (1)$$

E_t = Electric Energy;

n_T = Sunny Day;

α_t = Amount Fuel use for produced of 1 unit electric energy in TPP

5.2 Economical Effect :

Amount of revenues cane be calculated by

$$\text{Revenues} = \sum_1^n E_t \lambda_t \text{ price} \quad (2)$$

E_t = Energy produce by SPS for t time;

λ_t = Fuel we use for produce 1 unit energy in TPP

Price = cost of 1 unit fuel.

Thus SPS is so the economical and environmental benefits.

Work done:

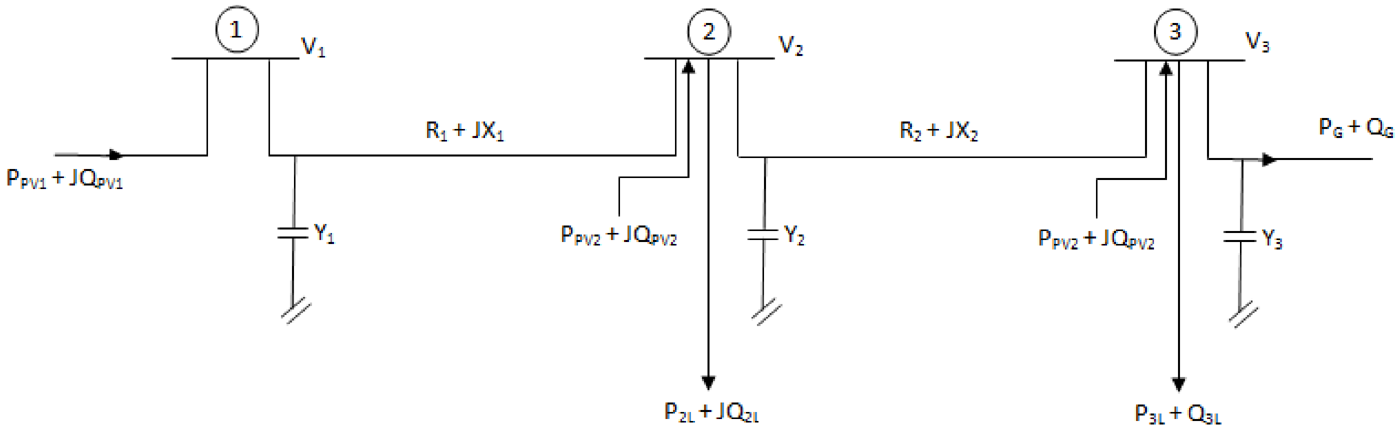

Fig-3 single line diagram of grid connected PV system

PV Power at each bus:

Power flow analysis of LV network of MLDG hybrid system is necessary to calculate rating of buses. To calculate voltage, active power, reactive power at different buses Newton Raphson method should be used[7]. Figure-3 shows the LV network power distribution at different buses, where parameters are denoted as ;

Real power at kth bus (P_k)

Reactive power at kth bus (Q_k)

Real power loss at Kth bus ($P_{loss,k}$)

Reactive power loss at Kth bus ($Q_{loss,k}$)

Real load at (Kth+1) bus (P_{Lk+1})

Reactive load at (Kth+1) bus (Q_{Lk+1})

Resistance between bus Kth and Kth+1 (R_k)

Reactance between bus Kth and Kth+1 (X_k)

Shunt admittance connected at bus kth (Y_k)

Voltage at Kth bus (V_k)

Real power supplied by nth DG (P_{pvn})

Reactive power supplied by nth DG (Q_{pvn})

Distance from grid to PV in km (G)

Length between grid to Kth bus in km (L)

Power of MLDG system can be calculated

$$P_{k+1} = P_k - P_{loss,k} - P_{Lk+1} \quad (3)$$

$$P_{k+1} = P_K - \frac{P_k}{V_k^2}\{P_k^2 - (Q_k - Y_k V_K^2)\} - P_{Lk+1} \quad (4)$$

Active and reactive power at bus -1

$$P_{V1} = \left[\frac{V_1^2}{R_1} P_{V1loss} - (P_1^2 + Q_1^2) - \left(Q_{PV1}^2 - 2P_1P_{V1} - 2Q_1Q_{V1}(G/L)\right)\right]^{1/2} \quad (5)$$

$$Q_{V1} = \left[\frac{V_1^2}{R_1} P_{V1loss} - (P_1^2 + Q_1^2) - \left(P_{PV1}^2 - 2P_1P_{V1} - 2Q_1Q_{V1}(G/L)\right)\right]^{1/2} \quad (6)$$

Description of Location (Location and Sizing Issues)

Proper location and size are very important for DGs installation to improve the power loss and for better power quality[8].

Improper selection of DGs location lead to higher power loss than without DGs. For optimum penetration and minimum loss the rating of DGs should be 2/3 capacity of incoming generation at 2/3 length of line[9].

Results:

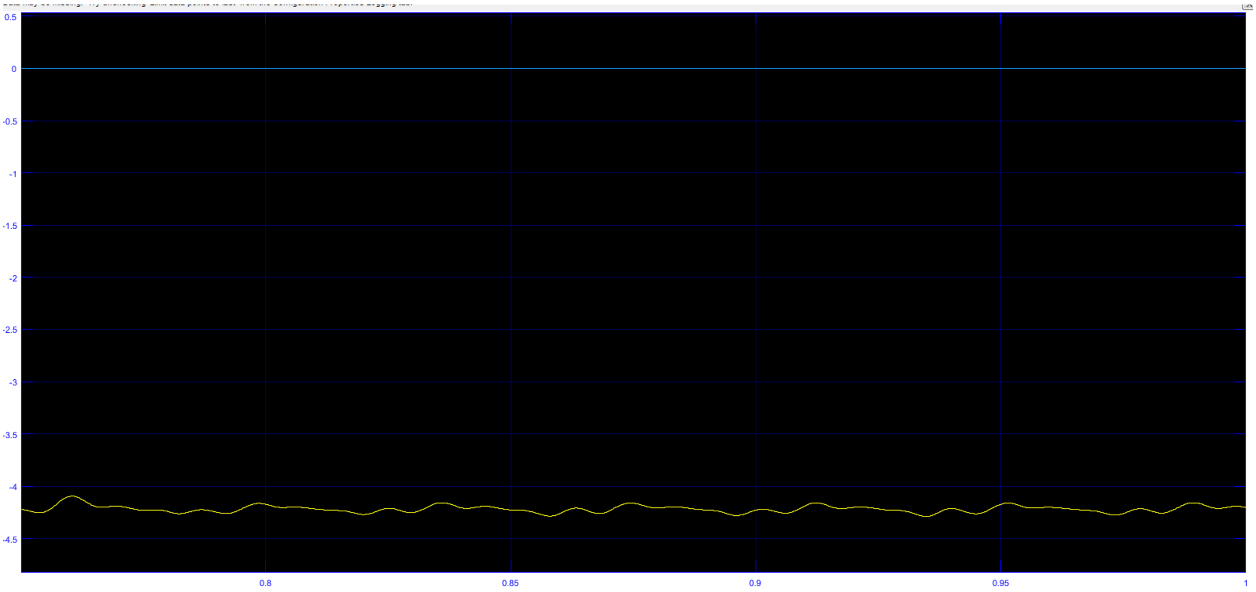

Fig- 4 Power share by grid

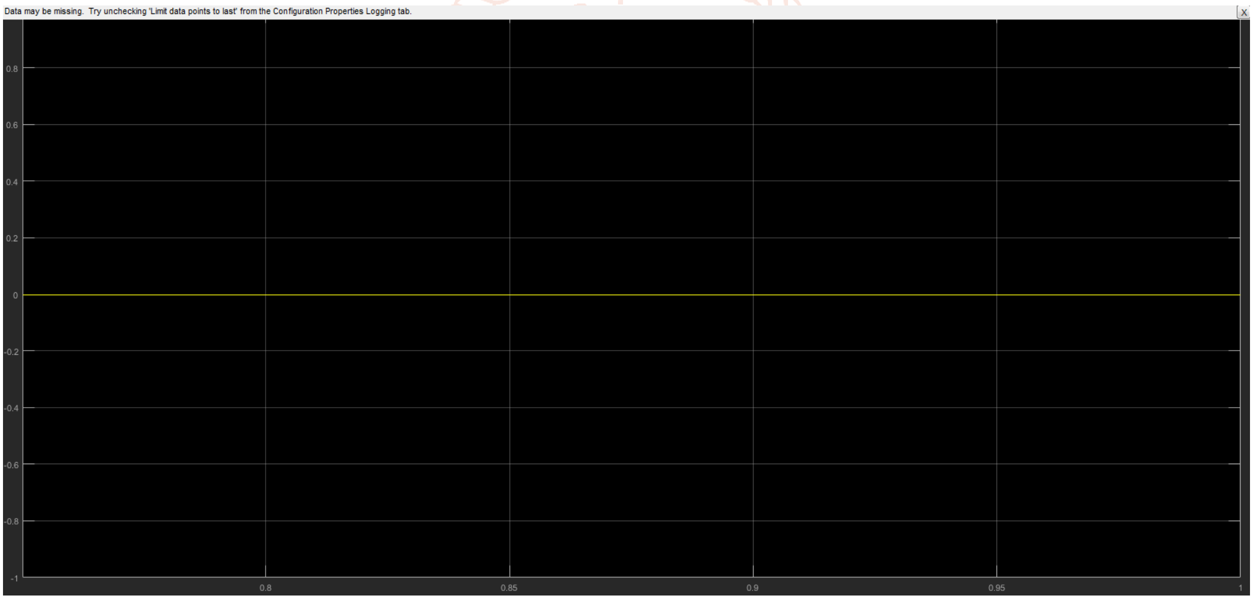

Fig-5 Graph tan Ø

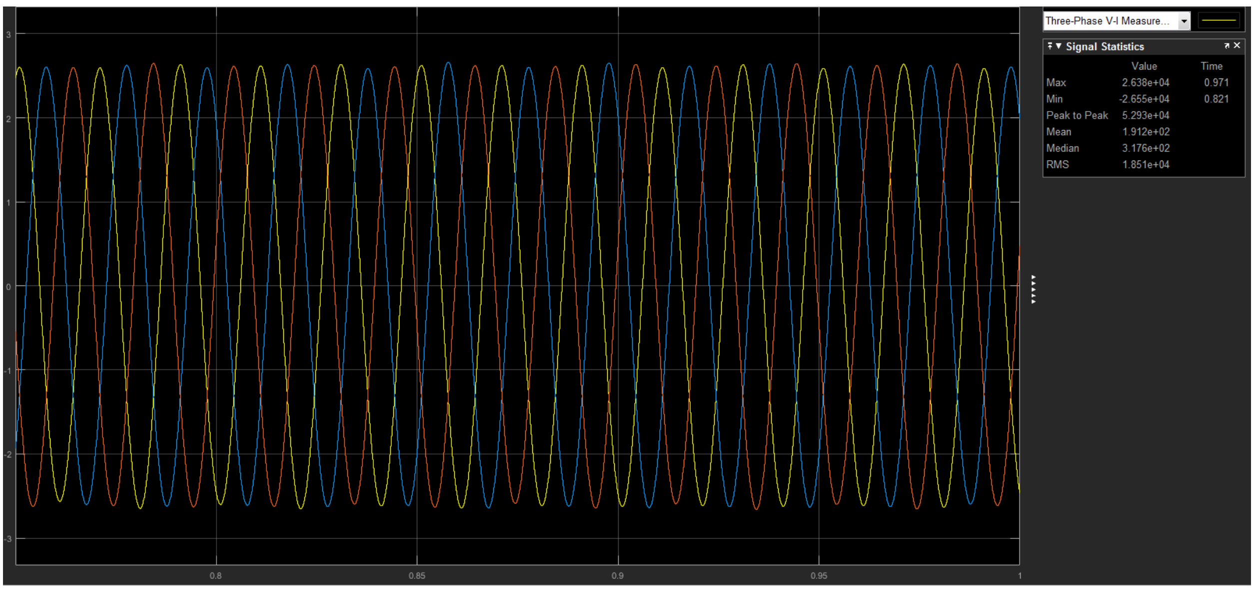

Fig-6 Grid Voltage

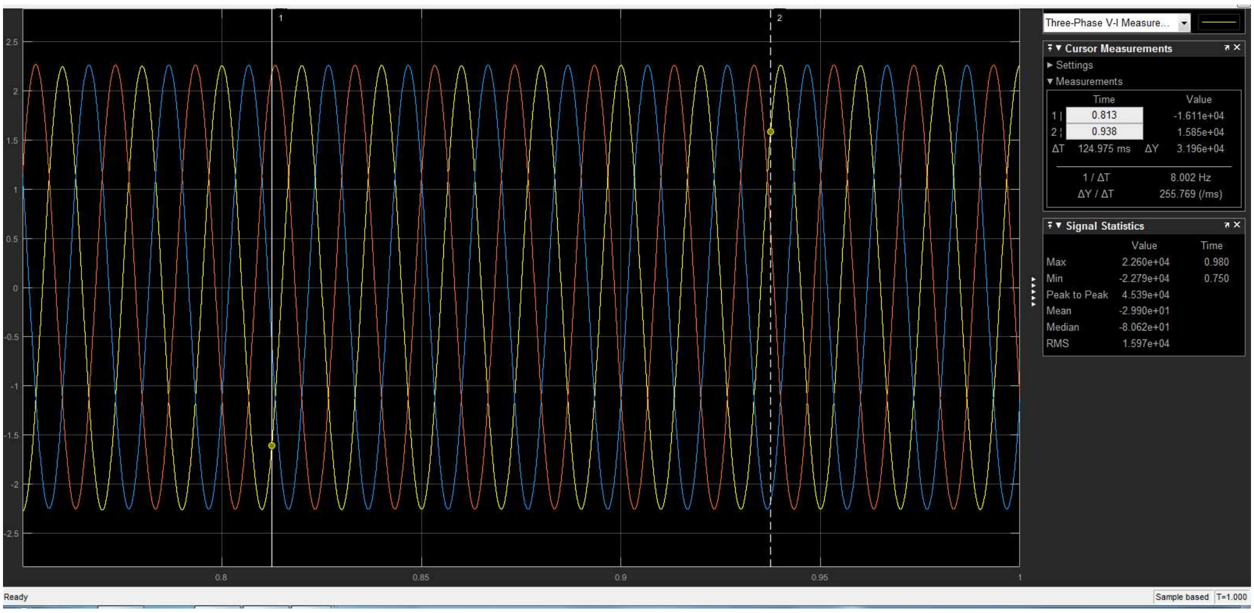

Fig-7 Grid current

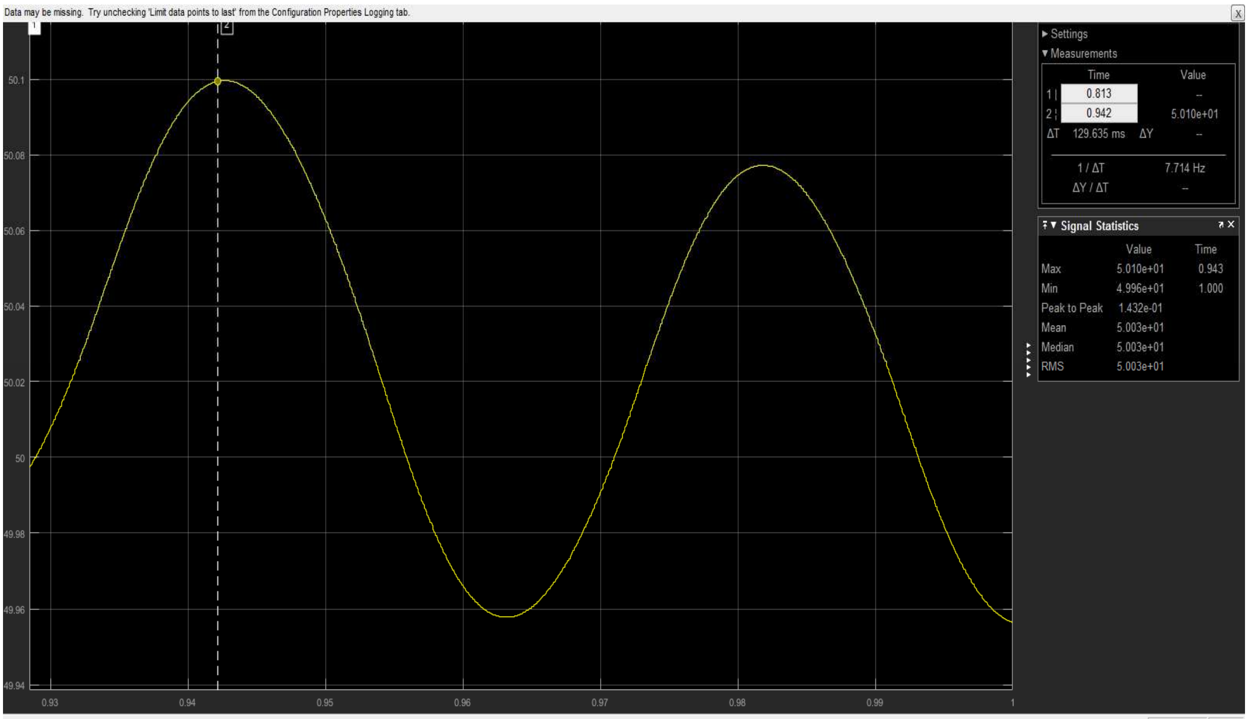

Fig-8 Grid frequency

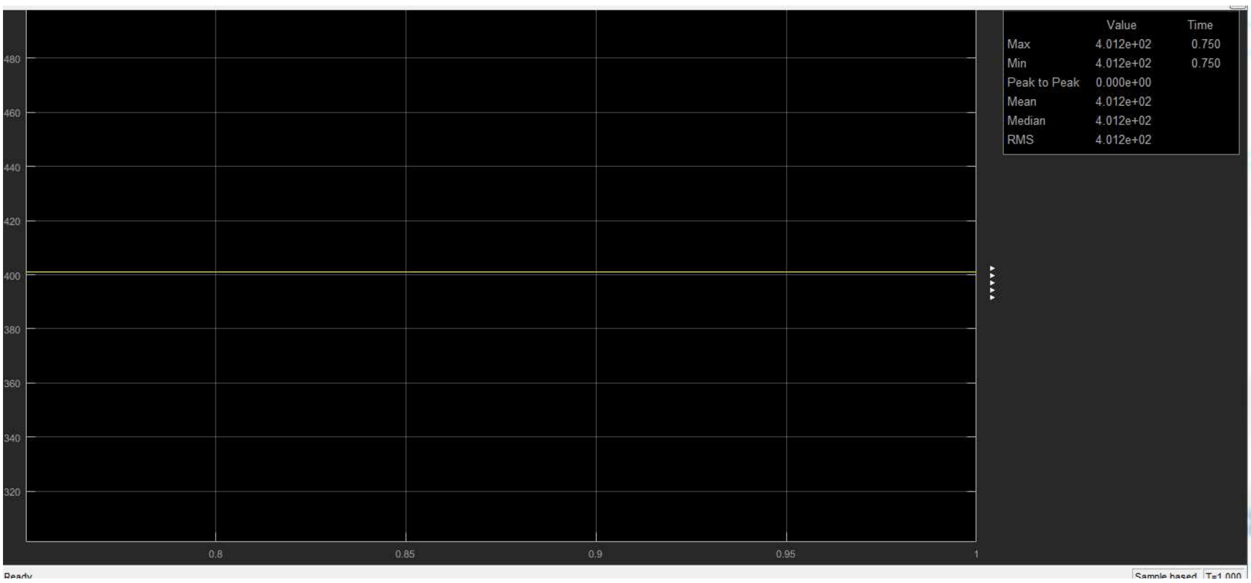

Fig-9PV voltage

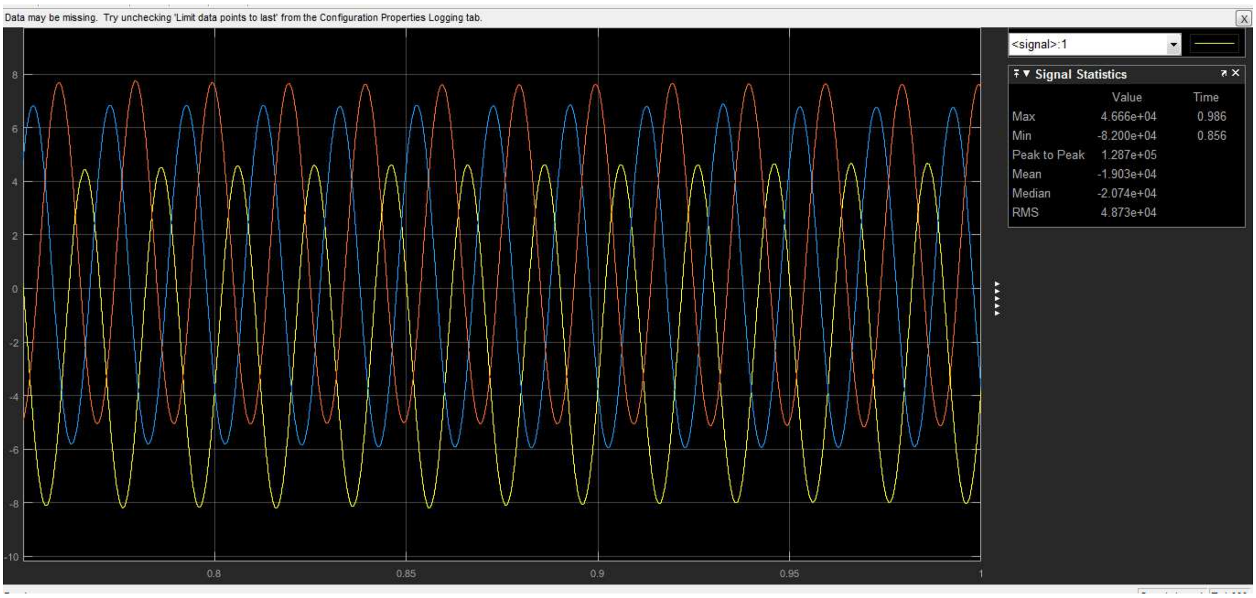

Fig-10 Current drown by load

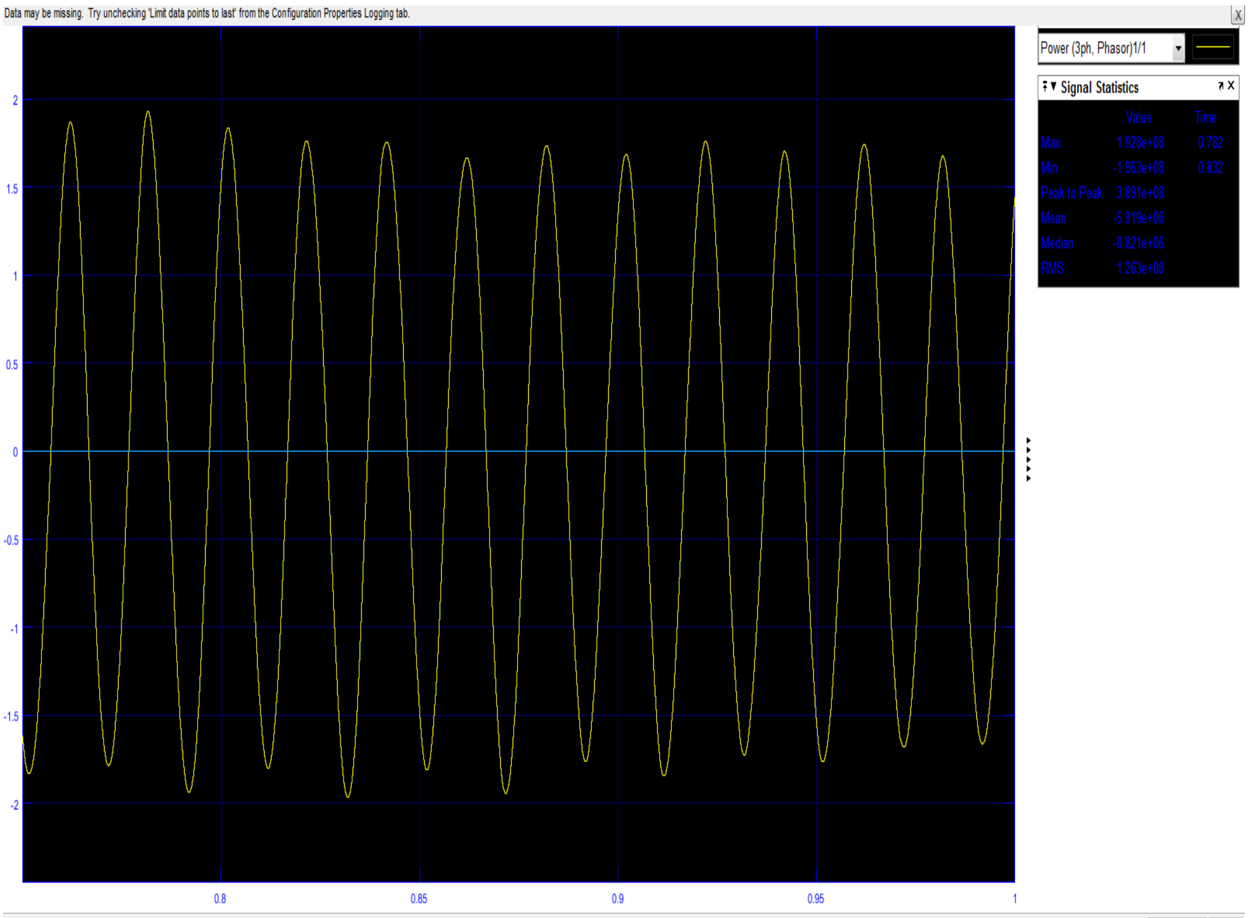

Fig-11 Active power given by PV

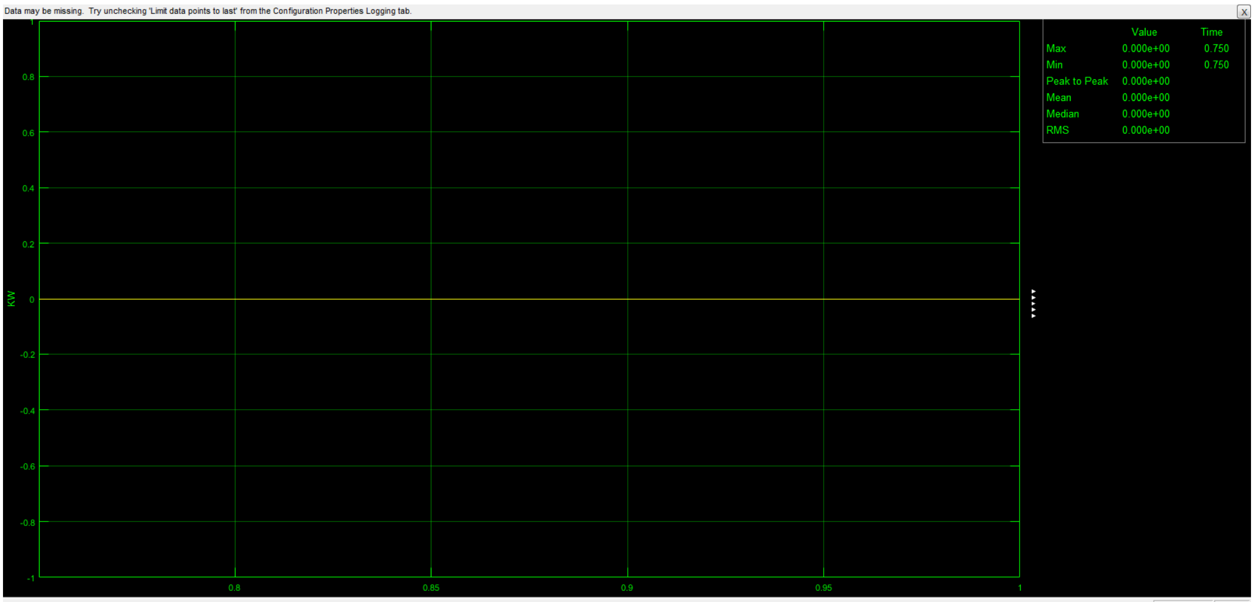

Fig-12 Reactive power at inverter terminal

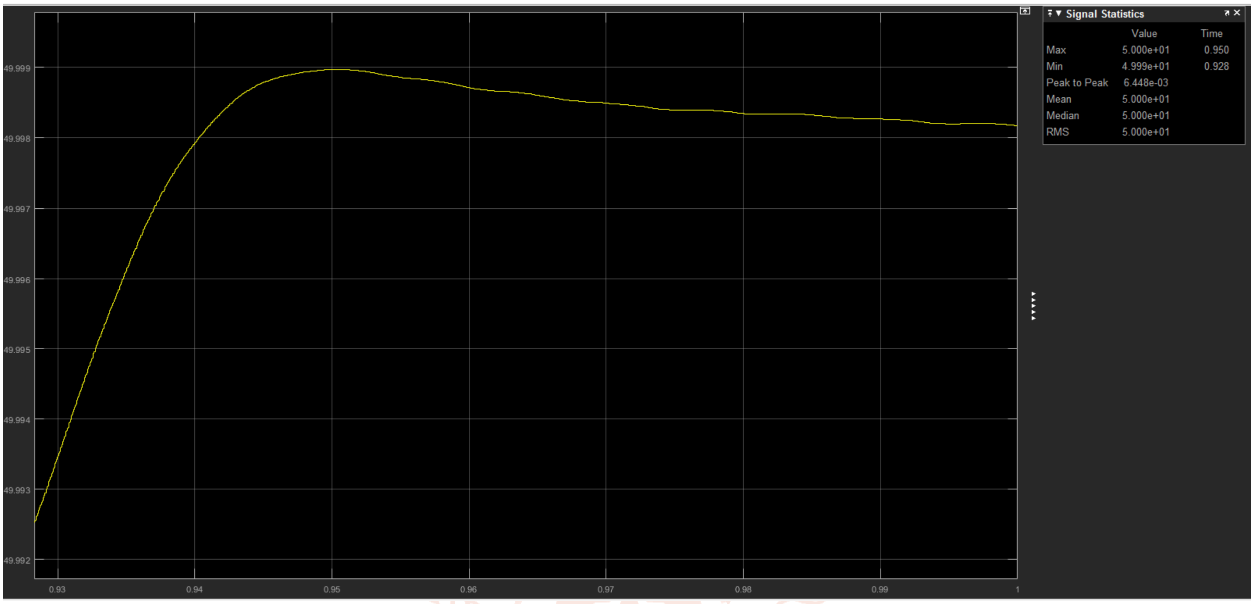

Fig- 13 Grid frequency With out shunt reactor

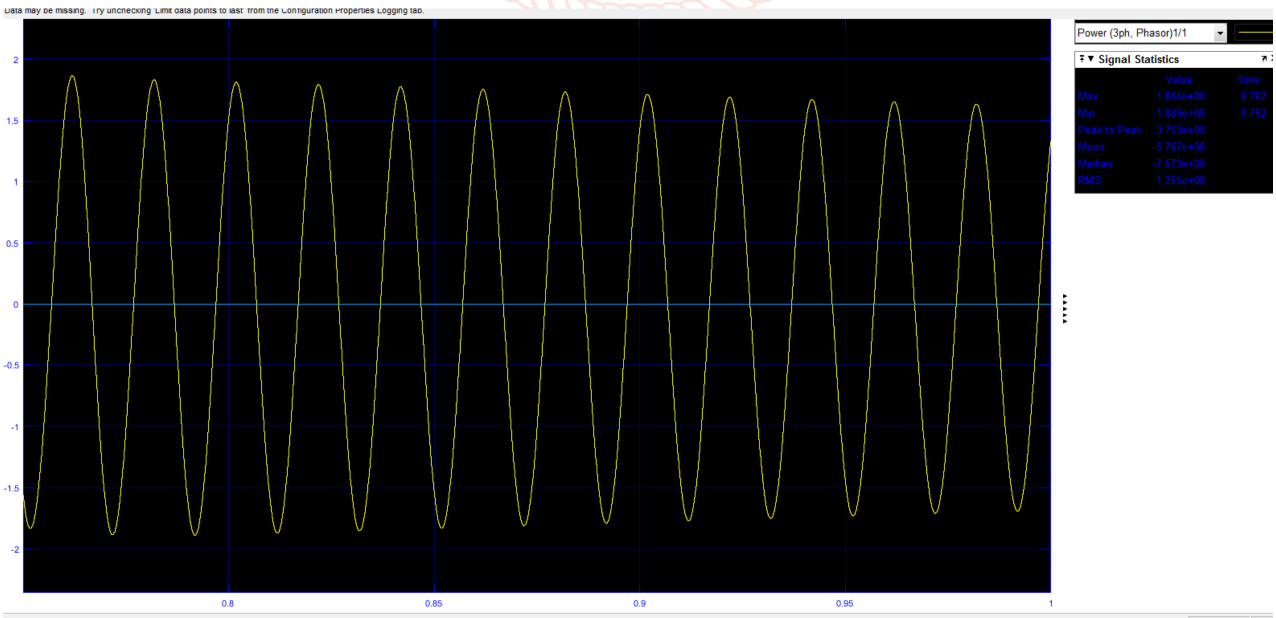

Fig- 14 Active power inverter end With out shunt reactor

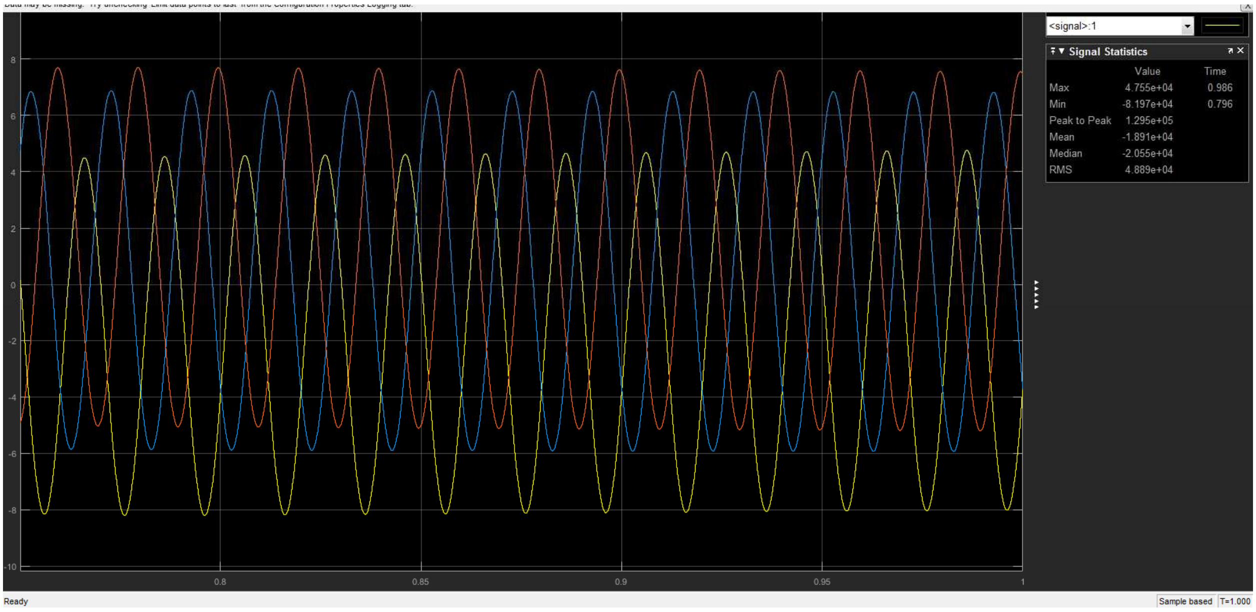

Fig-15-3 phase current drown by load without shunt reactor

Conclusion:

The PV hybrid system with power grid connected has been executed with STATCOM in the SIMULINK/MATLAB as shown in Fig. 1. The proposed system comprises of PV Panel which is fastened to the universal bridge to change dc into ac supply. The ac supply from hybrid PV/grid system is being provided to grid which is unbalanced and includes harmonics. Power quality development with the help of STATCOM has been analyzed. STATCOM synchronize the bus voltage and keep the reactive power. The hybrid PV/grid system with STATCOM is being examined with the help of MATLAB/SIMULINK. STATCOM upgrades the performance of power system and make it balanced as shown in different wave forms. The voltage stability of the STATCOM is shown by changing the inductive load which adjusts the load side voltage and current almost same. The output of STATCOM is connected in parallel with 1.25/25 KVA step up delta-star transformer. A filter bank is supplied at the end of STSTCOM output to digest the harmonics. The principal side of this transformer is fed with Voltage source Inverter and 3000 µF Capacitor is used as a dc voltage source for inverter.

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