

Solar Converter Performance Analysis Fitting Load at Two Different Local Areas

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Abstract: Multilevel converters are divided into diode clamp inverters, flying capacitor inverters and cascade inverters. The main objective of this work is to design a solar energy system to move loads away from production points and study the system to improve its reliability and efficiency. And analyze the system with the inverter field-oriented feedback control under transient load conditions to analyze the efficiency of the system in driving motor loads. The simulated work in this work demonstrates the possibility of using a photovoltaic cell to power a motor via a three-phase bridge inverter. It can be concluded that this work will contribute to the analysis of solar modules for the operation of a motor using a PWM inverter. The work also aims to perform an analysis of the solar energy system that moves loads away from the point of generation. The drive commands at the load points are analyzed during the process, taking into account the transient load conditions.

Keywords: PWM, PV system, solar, MPPT.

I. INTRODUCTION

Multilevel converters are divided into diode clamp inverters, flying capacitor inverters and cascade inverters. Intermediate circuit capacitors with the same capacity per unit, diode inverters have the least number of capacitors among three types, but require additional blocking diodes. Flying capacitor inverters require most capacitors. However, CMLI is considered to be the simplest structure. CMLI offers a combination of voltage levels with extremely low harmonics. Another advantage is that the mass inverter can be commercially available without projection, which requires only the inverter with the lower power state to be custom built. Therefore, the cascade inverter has been extensively studied and used in the fields of static VAR compensators (SVC), power line conditioners and voltage stabilizers. It should be noted that the cascade inverter could be a good choice for high voltage motor drive applications as well as upper branches due to other advantages of the modular circuit layout and housing [1] - [2]. The benefits of CMLI are hampered by the increase in the number of circuit breakers and DC sources. In order to minimize the degradation of the CMLI, a new structure is

being developed consisting of a multistage DC link inverter and a network of impedance sources [3-4]. Various modulation processes were analyzed using a powerful and mathematically rigorous method that provides the analytical expressions for the inverter output phase voltages.

II. LITERATURE REVIEW

Poyyamani Sunddararaj et al. [5] In this article, another plan and another sort of chopper circuit control is proposed and arranged with the series and equal association of the electronic force switches for bidirectional activity of the converter. The bidirectional activity of the proposed converter makes it reasonable for module electric vehicle applications as the lattice becomes more brilliant.

Noyal, M.A et al. [6] In this theory, the compelled and uniform energy quality conditioner was proposed to further develop the energy quality in wind conditions. Bunch registering is organized so that the distinctive leeward distances (between the turbines) can be analyzed with at least revamping exertion. Data gathered distantly for a disconnected evaluation of wind turbine configuration, each wind turbine in the recreation center is furnished with an IoT base.

Moussaab Bounabi et al. [7] This article proposes another control structure for two three-stage multistage inverter geographies for framework associated photovoltaic (PV) frameworks. This control conspire incorporates the utilization of spatial vector beat width regulation (SVPWM) innovation to control diode inverter (DCI) and course inverter geographies, just as the combination of molecule swarm improvement innovation (PSO) to control photovoltaic. Framework at MPP.

S.R. Pendem et al. [8] PSC diminish the yield force of the photovoltaic boards (photovoltaic boards) and address numerous places of most extreme force of the yield (properties IV and PV) because of conflicting force misfortunes between them. PV frameworks rely upon the concealing example,

however on the concealed region, the geographies of the PV generators and the actual situation of the concealed PV modules in the game plan.

III. OBJECTIVE

The work proposes to attain following key objectives from the research:

- Designing of a solar energy system for driving loads away from the generating points and study the system for improving its reliability and efficiency.
- The motor connected in the system shall be driven by the solar power along with certain constant loads at two areas of loading.
- The Analysis of the system with the field oriented feed back control of inverter at transient loading conditions to analyze the system efficiency in driving the motor loads.
- The comparative analysis of designed converter with feed-back control for its effectiveness at changing loading conditions.

IV. METHODOLOGY

Modeling of solar PV system

The performance of individual components is modeled using deterministic or probabilistic approaches. This chapter discusses the basic modeling structures of solar energy systems and the modeling of converters in dual range systems.

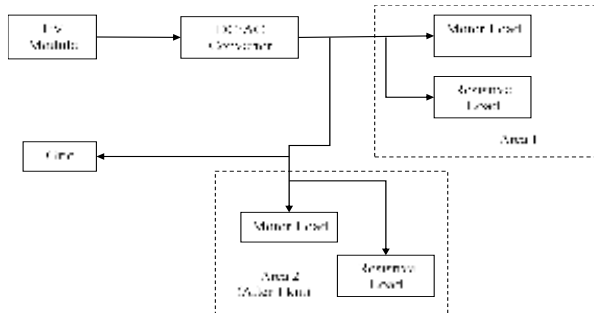


Fig. 1 Proposed Hybrid energy system topology

4.2 PV Module modeling:

Photovoltaic cells have a single operating point where the current (I) and voltage (V) values of the cell determine the maximum output power. These values correspond to a certain resistance which is equal to V/I. A simple equivalent circuit diagram of a PV cell is shown in Fig.2.

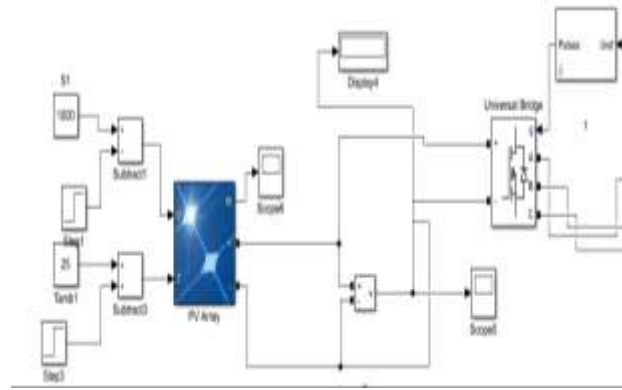


Fig. 2 Modeled solar system

A cell series resistance (R_s) is connected in series with parallel combination of cell photocurrent (I_{ph}), exponential diode (D), and shunt resistance (R_{sh}). I_{pv} and V_{pv} are the cells current and voltage respectively. It can be expressed as

$$I_{pv} = I_{ph} - I_s \left(e^{q(V_{pv} + I_{pv} R_s) / nKT} - 1 \right) - (V_{pv} + I_{pv} R_s) / R_{sh} \quad \text{Eq (3.2.1)}$$

Where:

I_{ph} - Solar-induced current

I_s - Diode saturation current

q - Electron charge ($1.6e^{-19}C$)

K - Boltzmann constant ($1.38e^{-23}J/K$)

n - Ideality factor ($1 \sim 2$)

T - Temperature 0K

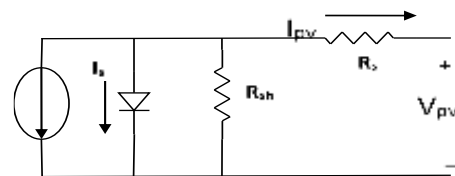


Fig. 3 Equivalent circuit of solar PV cell

The solar induced current of the solar PV cell depends on the solar irradiation level and the working temperature can be expressed as:

$$I_{ph} = I_{sc} - k_i (T_c - T_r) * \frac{I_r}{1000}$$

Where:

I_{sc} Short-circuit current of cell at STC

k_i Cell short-circuit current/temperature coefficient(A/K)

I_r Irradiance in w/m

T_c, T_r Cell working and reference temperature at STC

A PV cell has an exponential relationship between current

and voltage and the maximum power point (MPP) occur at the knee of the curve as shown in the Fig 4.

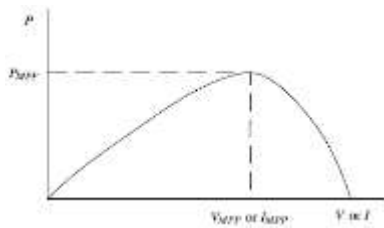


Fig. 4 Characteristic PV array power curve

Table 4.1 : PV module Parameters

Model	1Soltech 1STH
Maximum Power	213.5 Watts
Number of parallel strings	40
Number series modules	10
Open circuit voltage	36.3 Volts
Shot circuit current	7.84 Ampere
Irradiation	900 wb/m ²
Temperature	30°C

Proposed Converter control system implementation 1 Pulse Width Modulation

A. Principle of Pulse Width Modulation (PWM)

Fig 5 shows circuit model of a single-phase inverter with a Centre tapped grounded DC bus, and Fig 6 illustrates principle of pulse width modulation.

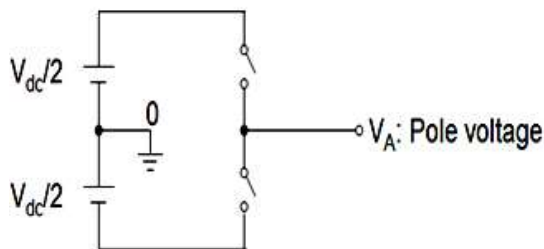


Fig. 5 Circuit model of a single-phase inverter

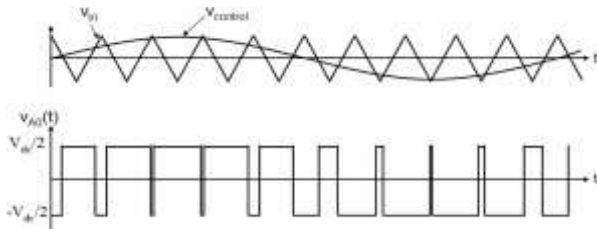


Fig. 6 Pulse width modulation.

As depicted in Fig 6, the inverter output voltage is determined in the following

- When $V_{\text{control}} > V_{\text{tri}}$, $V_{A0} = V_{dc}/2$
- When $V_{\text{control}} < V_{\text{tri}}$, $V_{A0} = -V_{dc}/2$

Also, the inverter output voltage has the following features:

- PWM frequency is the same as the frequency of V_{tri}
- Amplitude is controlled by the peak value of V_{control}
- Fundamental frequency is controlled by the frequency of V_{control}

B. Principle of Sinusoidal PWM

Fig 7 shows circuit model of three-phase PWM inverter and Fig 8 shows waveforms of carrier wave signal (V_{tri}) and control signal (V_{control}), inverter output line to neutral voltages are V_{A0} , V_{B0} , V_{C0} , inverter output line to line voltages are V_{AB} , V_{BC} , V_{CA} respectively.

As described in Fig 8, the frequency of V_{tri} and V_{control} is

- Frequency of $V_{\text{tri}} = f_s$
- Frequency of $V_{\text{control}} = f_1$

Where, f_s = PWM frequency and f_1 = Fundamental frequency

The inverter output voltages are determined as follows:

- When $V_{\text{control}} > V_{\text{tri}}$, $V_{A0} = V_{dc}/2$
- When $V_{\text{control}} < V_{\text{tri}}$, $V_{A0} = -V_{dc}/2$

Where, $V_{AB} = V_{A0} - V_{B0}$, $V_{BC} = V_{B0} - V_{C0}$, $V_{CA} = V_{C0} - V_{A0}$

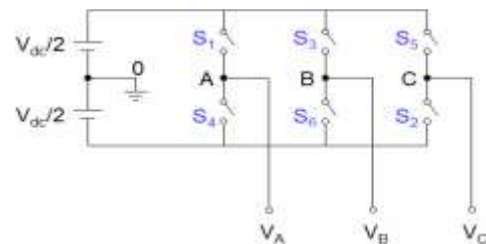


Fig. 7 Three-phase PWM Inverter of general three-phase sine-PWM inverter

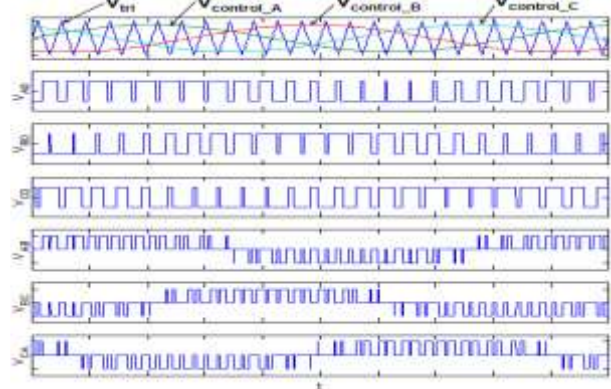


Fig. 8 waveforms of carrier wave signal

The block diagram of the three-phase DC-AC inverter connected to the grid is shown in Figure 4.8.

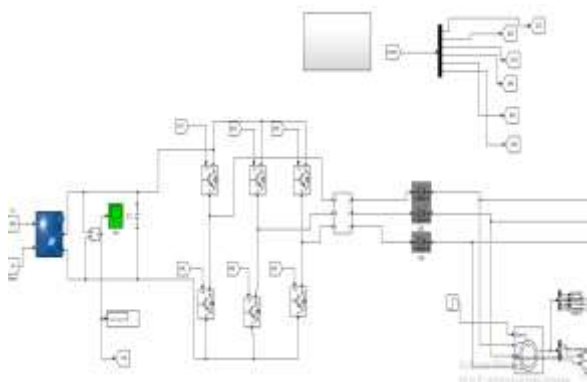


Fig. 9 MATLAB/SIMULINK designing of three phase converter

The inverter control planning has been done as such as to further develop the framework boundaries. The planning has been done in dq0 reference casing to facilitate the investigation of the basic parts and their separate changes. The framework consistently keeps a beware of the variable boundaries and updates according to the prerequisite.

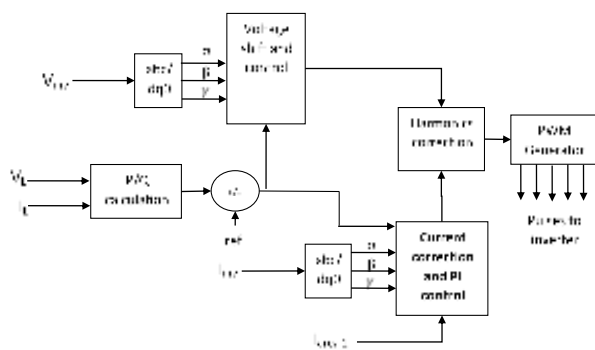


Fig. 10 load line driving adaptive multi-objective PWM control

V. RESULTS

The work here contains a model of a solar panel network in which each module is powered with a radiation of 900 Wb / m² and a temperature of 30°C. The work here is done not only to improve the power generated by the renewable energy source, but also to accommodate the different load points by making sure the system drives the loads over two spaced areas. The goal is to be achieved by developing an inverter controller that will produce improved and stable output power for the grid. This chapter deals with the performance of the solar-based renewable energy system that will also be integrated into the grid. Benchmarking was done with respect to the system output power.

In this simulation model, the inverter input voltage is supplied by the solar panel. The inverter is powered by the voltage regulator. The thesis analyzes two systems which are the following:

System 1: Solar fed two area loads having inverter controlled from motor field oriented feedback control

System 2: Solar fed two area loads having inverter controlled from proposed load line driving adaptive multi-objective PWM control

System 2 is powered by the proposed controller and stress analysis was performed to examine the efficiency of the designed controller. This chapter discusses the results in the following three cases based on displacement loads in two areas.

CASE 1: Solar system driving loads at area 1

CASE 2: Solar system driving loads at area 1 and area 2

Case 3: Analysis of converter system during transient switching at area 2

The analysis was carried out by analyzing the power delivered on the load line of zone 1 and zone 2 and then performing a comparative analysis of all the electrical parameters at the respective analysis point of the coaching engine loads.

CASE 1: Solar system driving loads at area 1

The inverter changes over the DC yield voltage of the close planetary system to AC. This inverter is beat with fundamental control innovation that utilizes voltage and current controllers and produces beats after they are changed. The heap line is associated between two zones that drive 410 V engine loads. The framework is associated with the transformer and in this way incorporated into the organization. The graphical yield waveforms of voltage, current, viable force and receptive force are displayed in the accompanying figure. Also, different burdens are checked to analyze the proficiency and dependability of the framework. Burdens at some separation from zone 2 are not associated in this investigation.

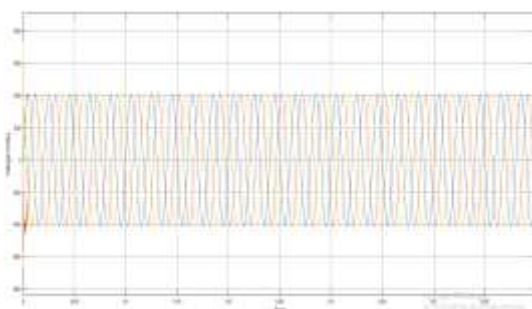


Fig. 11 Voltage at the loading line in system 1 with loads from area-1

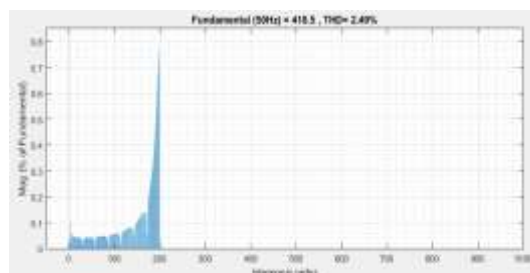


Fig. 12 THD% in voltage at loading line in system 1 with loads from area-1

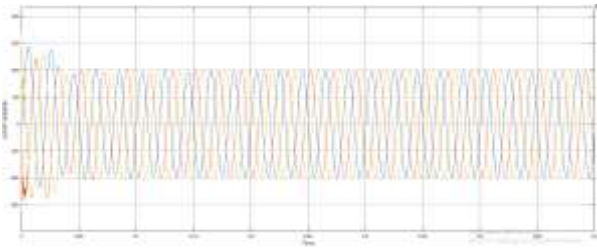


Fig. 13 Current at the loading line in system 1 with loads from area-1

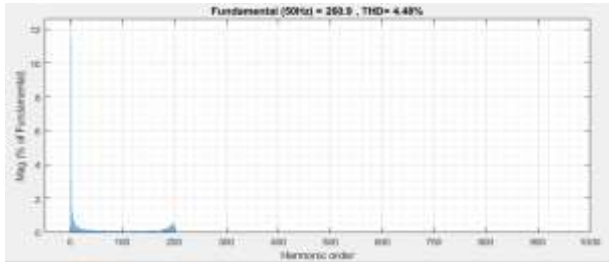


Fig. 14 THD% Current at the loading line in system 1 with loads from area-1

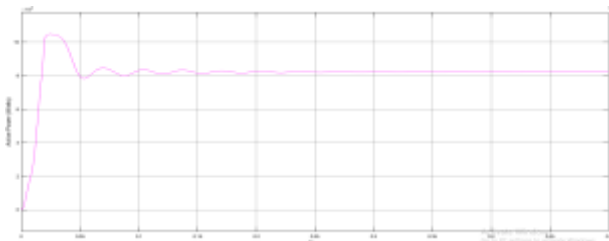


Fig. 15 Active Power at the loading line in system 1 with loads from area-1

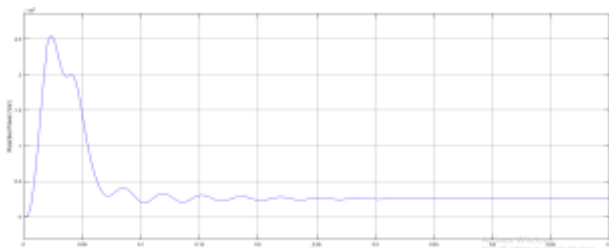


Fig. 16 Reactive Power at the loading line in system 1 with loads from area-1

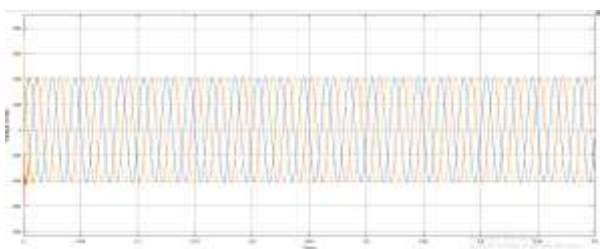


Fig. 17 Voltage at the loading line in system 2 with loads from area-1

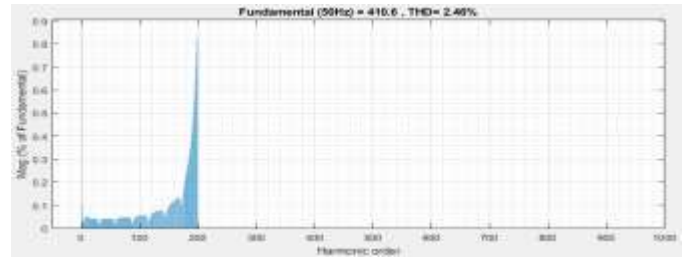


Fig. 18 THD% in Voltage at the loading line in system 2 with loads from area-1

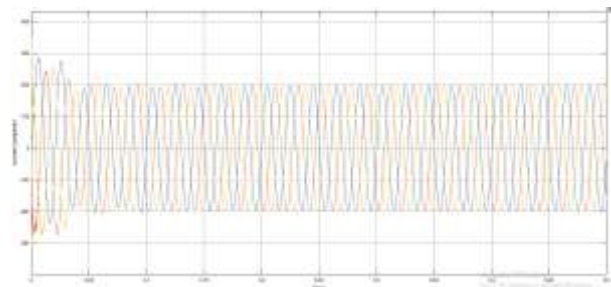


Fig. 19 Current at the loading line in system 2 with loads from area-1

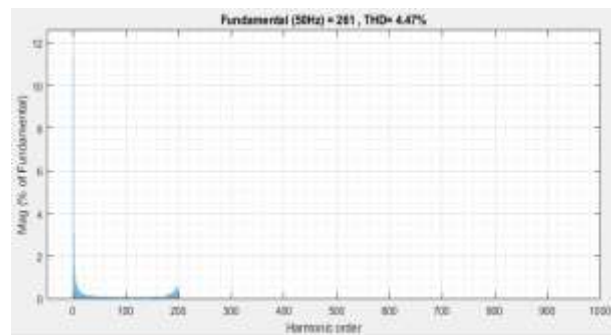


Fig. 20 THD% in Current at the loading line in system 2 with loads from area-1

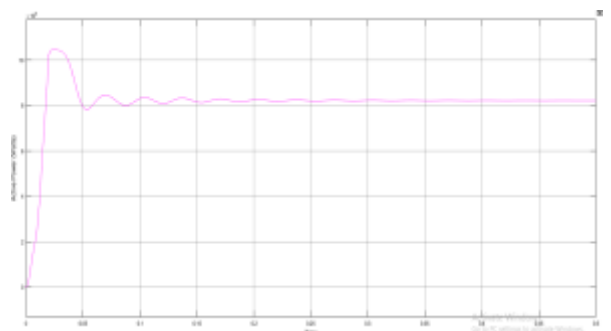


Fig. 21 Active Power at the loading line in system 2 with loads from area-1

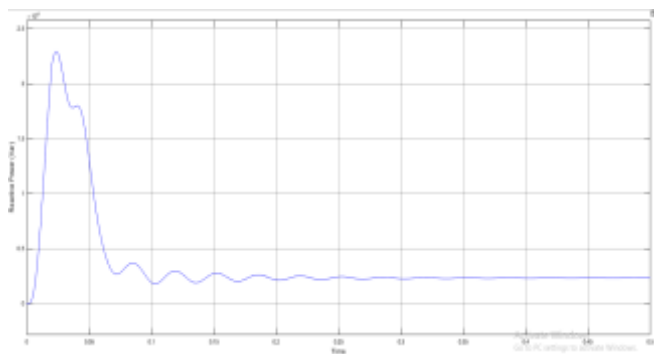


Fig. 22 Reactive Power at the loading line in system 2 with loads from area-1

Table 1 Comparative analysis of system 1 and system 2 driving area 1		
Parameters	System 1	System 2
Active Power	82.18 KW	82.21 KW
Reactive Power	2563 Var	2308 var
THD% in voltage	2.49 %	2.46 %
THD% in current	4.48 %	4.47 %

CASE 2: Solar system driving loads at area 1 and area 2

The two systems, which are designed with different converter controls, are also analyzed for the control of variable loads in zone two, which is some distance away from where the electricity is produced by the solar system. The converters are also tested for their efficiency in driving loads over a certain distance.

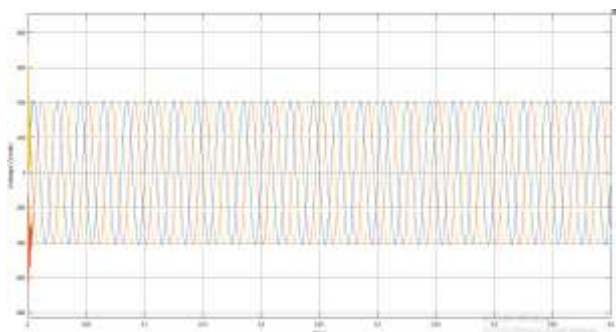


Fig. 23 Voltage at the loading line in system 1 with loads from area-1 and area-2

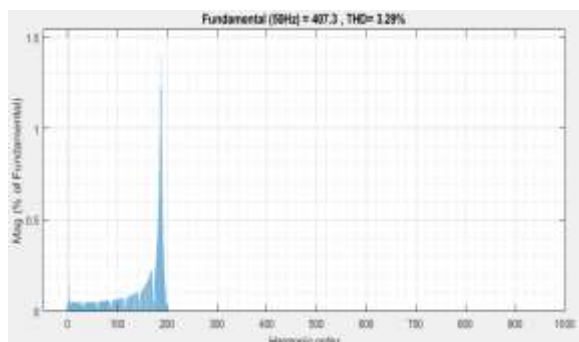


Fig. 24 THD% in voltage in system 1 driving loads from area-1 and area-2

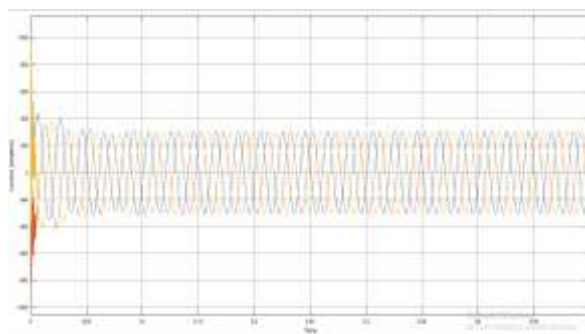


Fig. 25 Current at the loading line in system 1 with loads from area-1 and area-2

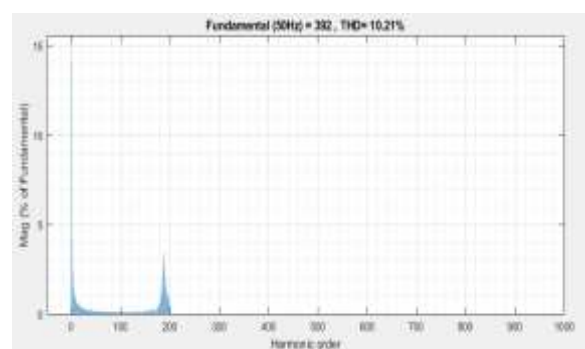


Fig. 26 THD% in current in system 1 driving loads from area-1 and area-2

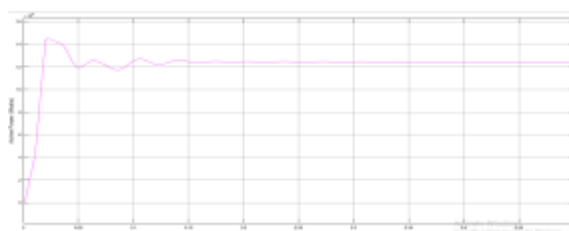


Fig. 27 Active Power at the loading line in system 1 with loads from area-1 and area-2

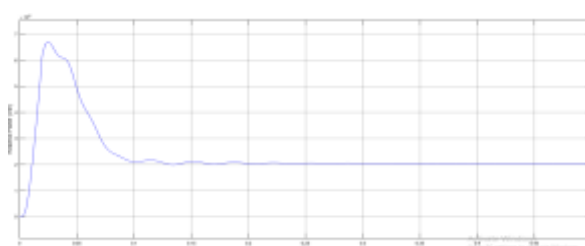


Fig. 28 Reactive Power at the loading line in system 1 with loads from area-1 and area-2

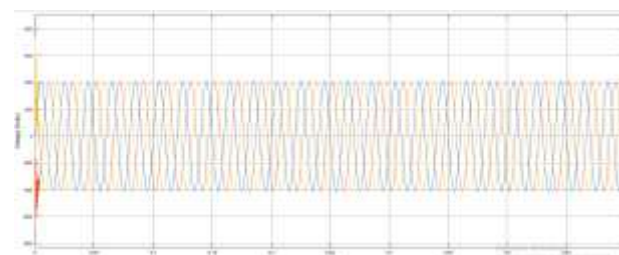


Fig. 29 Voltage at the loading line in system 2 with loads from area-1 and area-2

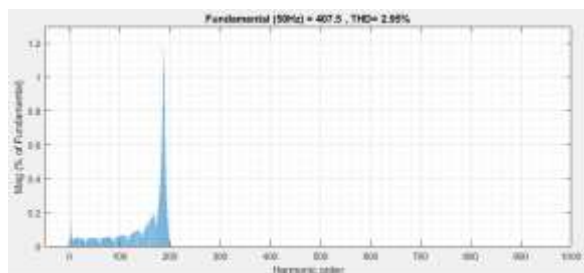


Fig. 30 THD% in voltage in system 2 driving loads from area-1 and area-2

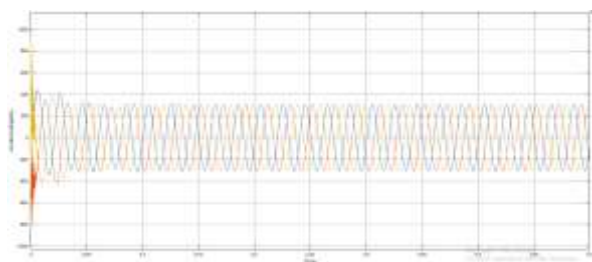


Fig. 31 Current at the loading line in system 2 with loads from area-1 and area-2

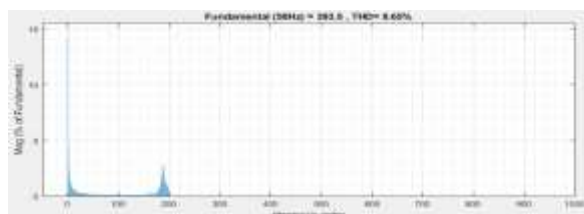


Fig. 32 THD% in current in system 2 driving loads from area-1 and area-2



Fig. 33 Active Power at the loading line in system 2 with loads from area-1 and area-2

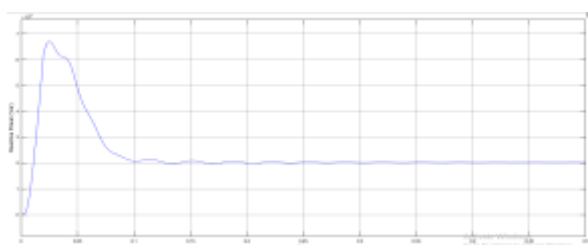


Fig. 34 Reactive Power at the loading line in system 2 with loads from area-1 and area-2

Table 2 Comparative analysis of system 1 and system 2 driving both the areas		
Parameters	System 1	System 2
Active Power	124.5 KW	124.9 KW
Reactive Power	20.46 KVar	20.19 Kvar
THD% in voltage	3.29%	2.95%

THD% in current	10.21%	9.65%
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CASE 3: Analysis of converter system during transient switching at area 2

For this investigation, we dissected the progressions in the current waveform at the stretches where the heap was unexpectedly turned on the organization. For this reason, a three-stage switch with the heap was utilized, the underlying condition of which stays in the off state. At 0.1 seconds, the change changes to its state and the heap is associated with the line. The mains voltage stays as before and is 410 volts. Changes in the current waveform were inspected by breaking down the THD level in the current waveform because of an unexpected burden on the line. The engine loads in zone two are then released after 0.3 seconds during the examination.

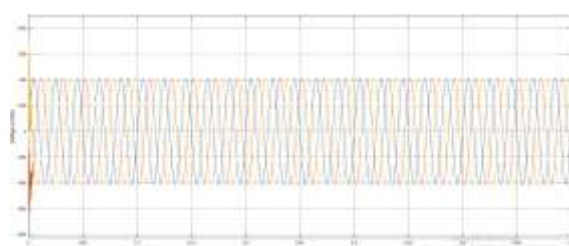


Fig. 35 Voltage in the line during transient switching at area 2 in system 1

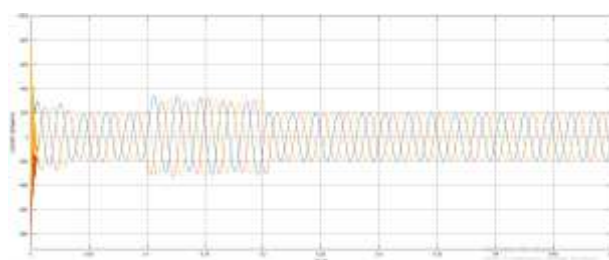


Fig. 36 Current in line during transient switching at area 2 in system 1

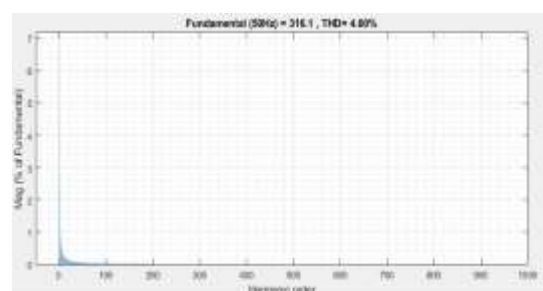


Fig. 37 THD% in current at the point of loading in system 1

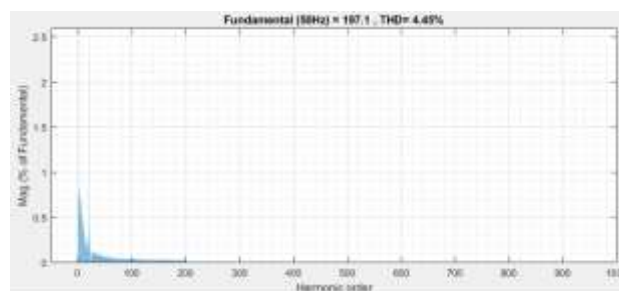


Fig. 38 THD% in current at the point of off-loading in system 1

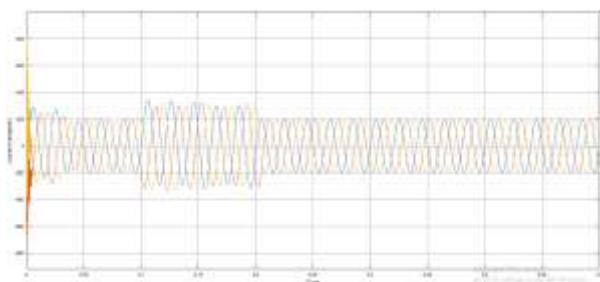


Fig. 39 Current in line during transient switching at area 2 in system 2

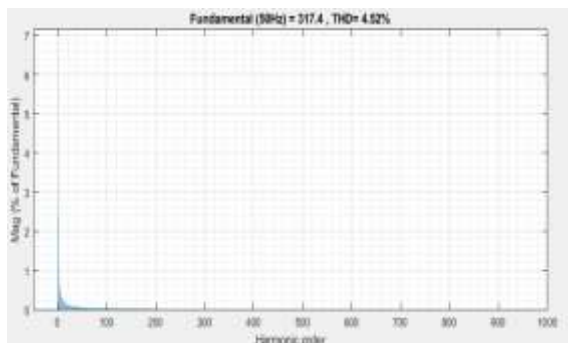


Fig. 40 THD% in current at the point of loading in system 2

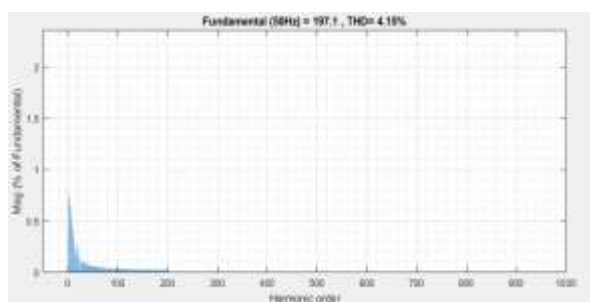


Fig. 41 THD% in current at the point of off-loading in system 2

From the past figures it tends to be presumed that the contortion level of the current assimilated at the charging terminal for the transient charge of 0.1 and 0.2 seconds has diminished. The progressions in the two frameworks are critical and in this manner the planned regulator end up being a successful decision for driving the inverter in the framework. The accuse was completed of various sorts of burdens at various occasions, and hence the examination is additionally viable in checking the charging states of the close planetary system at a specific separation from the point of generation.

Table 5.3 : THD% in current in load line loading in case of system 1 and system 2		
Parameters	System 1	System 2
During loading at 0.1 sec	4.60%	4.52 %
During off-loading at 0.2 sec	4.45%	4.15%

VI. CONCLUSION

The simulated work in this work demonstrates the possibility of using a photovoltaic cell to power a motor via a three-phase bridge inverter. It can be concluded that this work will contribute to the analysis of solar modules for the operation of a motor using a PWM inverter. The work also aims to perform an analysis of the solar energy system that moves the loads away from the point of generation. The drive commands at the load points are analyzed during the process, taking into account the transient load conditions.

The proposed controller is designed to generate pulses with PWM technology, the reference signal of which has been generated taking into account the load conditions of the system, which adapts to variations in the motor load points.

The actual output power of the system is improved in the system with the proposed multi-target adaptive PWM control of the load line drive due to the improved performance and reduced loss at various points of the drive loads in zones 1 and 2.

The additional analysis compared the performance of the two systems with the two time interval load cycle analysis. The analysis showed the efficiency of the proposed regulator in controlling the various loads with their sudden switching on the line.

VII. FUTURE SCOPE

This framework advances efficient power energy, which is vital in light of the fact that all energy sources are running out each day. Accordingly, individuals should be searching for new sustainable sources and sun based energy is surely perhaps the most ideal choice for this reason. Later on, a versatile neural organization based control will be intended for this three-source framework for further developed energy quality with an incorporated three-stage lattice as a cross breed sun based/solar. electral/power module framework. The arranged control conspire manages the line voltage and further develops the line quality proficiently. The mixture control framework can be updated with this control to work on its exhibition.

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