VARIABLE SOLAR IRRADIANCE AND VI-HARMONICS CONTROLLING USING UPQMC METHOD

CH. VINAY KUMAR¹, DR. P. RAM KISHORE KUMAR REDDY², DR. P. LAKSHMI SUPRIYA³,
¹Assistant Professor, Department Of Eee, Mahatma Gandhi Institute Of Technology
Chvinaykumar_Eee@Mgit.Ac.In
²Professor, Department Of Eee, Mahatma Gandhi Institute Of Technology
Prkumarreddy_Eee@Mgit.Ac.In
³Assistant Professor, Department Of Eee, Mahatma Gandhi Institute Of Technology
Plaxmisupriya_Eee@Mgit.Ac.In

ABSTRACT

Solar panels are really useful devices which help for power distributions & converting the sun’s energy and heat into usable electricity. Installing PV cells has been great for residential as well as commercial buildings, hospitals etc. but they are facing many problems. Like, power stability, quality three phase controlling harmonics. These problems need to be resolve because degrade the home equipment and electronic, electrical gadgets. In this research work unified power quality modified conditioner method has been involved. The solar PV board is coordinated with direct current, alternate current, in this scenario we are concentrate on DC power related to UPQMC. At every solar panel installation power reflections are common. So, remove the power fluctuations and inverting action is a major objective. All existed methods like GA, PSO, RFO are not suitable for this UPQC system. Because of this reason unified power quality modified conditioner (UPQMC) has been proposed. This is the combination of inverter network and controller gives to better accuracy, power quality with variable irradiance using UPQMC achieved more than 10% improvement compared to implemented methods.

Keywords: PQ, current PV, Harmonics, Voltage, Unified power.

I. INTRODUCTION:

UPQMC performs multiple tasks like Peakovershoot, stability, irradiance, voltage current curve adjustment. Energy sources like thermal, wind, hydraulic power systems are more stable compared to solar power system. Because all mentioned models are very efficient in design point of view. But, power generation using solar panels are not that much accurate, so need to improve the all elements which are mentioned above. In this research static compensator, dynamic voltage controller, power quality improvement is designed by UPQMC [1][2]. UPQMC is a shunt transformer design, stabilization has been simple for load variance, irradiance. Proposed method is a predictive control optimization technique utilizes the continuous model of PV(Photovoltaic) converter and train the active and reactive components. This UPQMC high-gain multiple level converter related to PV system, using this no need to design the control parameters for load unbalancing and uncertainties. This technique improves speed of controlling with rapid change in solar insolation. More over the conventional techniques results active power improvement. But, reactive power does not consider. So, this is computationally burden design. Our proposed method using UPQMC deals the both reactive and active power. UPQMC controller has been designed and simulated under different operating conditions using MATLAB, Simulink software under the different circumstances like solar irradiance. Simulation outcomes explains that proposed controller is maintained good accuracy at active and reactive controlling by different mode of operations[3][4].
Figure 1. UPQC model

Fig 1 explains that conversion of PV through grid. Here output filters are removes the noise and Peak over shoot by using KVL and KCL at AC side calculate the total grid current using below equation 1&2

\[ v_{\text{com}} - v_i = L_i \frac{di}{dt} + R_i i_i \]  
\[ v_i = \frac{2}{3} (V_{ph} + \gamma V_{ph} + \gamma^2 V_{ph}) \]

Above equations and block diagram has been archives less accurate for irradiance and load unbalancing conditions. So moving to proposed method that is UPQMC [5][6].

II. LITERATURE SURVEY

In power electronics systems, power quality (PQ) considered to be an essential concern in the present era. It needs to end up being fundamental, especially with the presentation of best in class equipment, whose general execution is unprotected to the top notch of intensity provided. Power quality issue is an event concerning shifting voltages, current or recurrence those consequences in a disappointment of end-use devices [1]. The fundamental view of conceiving UPQMC is the consolidated utilization of gathering energetic and shunt-modelled channels mainly to settle up poor-arrangement presentin addition to the ground level that is SCR capacitor banks, this made for responsive energy in power recurrence terms [2]. Displaying recreation of routine power conditioners appear at remain inescapable as energy hardware founded absolute framework being used for expanding the quality of the line in circulation systems [3]. The all-inclusive advantage of the UPQMC incorporates the improvement: it has an equivalent trademark to SCR organized capacitor banks of attaining capacity compensate in illustration the reasonable sinusoidal flows inside the existing control method [4, 5]. Additionally the most extreme power quality improvement apparatus for vulnerable nonlinear loads, which need genuine sinusoidal information supply [6]. Overall work clarifies about solar energy related information likewise PV frameworks are planned and need to demonstrate and tried with the proposed controller, to give the most extreme power. The control plan of Grid-associated PV framework is investigated for giving the ideal PV power and high quality of current infused into the network hence, high power quality, irradiance load unbalancing are neglected to clarify in literature [1-10]. So proposed UPQMC has been modifies the parameters at improvement manner[11-16].

III. METHODOLOGY

Objectives:

- The important factors to be considered in PQ measurement and tested the PV system with variable solar irradiance by real time data from vikram solar datasheet [11] at standard and NOCT. Canadian solar [12], Jinko solar [13] at final compare the system with proposed UPQMC.

- For the enhancement of PQ, the transient response and stability of the grid linked PV scheme is analyzed.
To analyze the individualities of PV systems with mitigate the PQ matters.

To analyze the dynamic behaviour of voltage and current loops on behalf of changeable ac &dc link voltage by the output inverter current.

Above all solar cells are placed in a figure 1 at PV cell place and tested with different circumstances calculate the power maximum, voltage, current, temperature variance etc. Figure 2 shows that different PV cells of various vendors like jinko solar, Canadian solar, vikram solar respectively. These three systems are placed in proposed UPQMC controller observe the various parameters which are mentioned above.

Fig 3 explains about voltage vs current and power in watts analysis with different irradiance like 1000, 600, 800, 400w/m². In this more temperature coefficients and partial shadings mechanism eliminated by six modules adjustment. This gives rise the 8% energy per watt.
4. UPQC implementation:

Fig 4 explains that unified power controlled modified conditioner. In this shunt transform design has been implemented. In figure 1 transformer design is implemented by series manner. So, power, current, voltage levels are not up to the rating. These all segments of UPQC paring diodes and inductors associated with shunt designs which is shown in above circuit diagram.

Fig 5 explains that structural arrangements of UPQMC coordinated with PV shunt design. This is a part of figure 4 the limitations of UPQC are improved with UPQMC PV systems. Here capacitor adjustment with diode connections are improved with modified conditioner. This circuits improves the additional features like phasor relations with I,V,P shown in below figure 6.
Fig 6 explains that all relations of PV array with respect to current, voltage, power. Below measurements useful for different elements calculation. That is Nominal Max. Power (Pmax), Opt. Operating Voltage (Vmp), Opt. Operating Current (Imp), Open Circuit Voltage (Voc), Short Circuit Current (Isc), Module Efficiency Operating Temperature.

A. **DC voltage Measurements**

\[ V_{dc} = \frac{\sqrt{2}V_S}{m} \]

\[ = \sqrt{2} \times 2301 = 375.2610 \approx 375.0 \text{V} \]  

In this equation 3 shows that RMS network energy related to VS. Here m is the adjustment factor that is default value 1. In this framework the maximum power rating is adjusted to 375-400 DC transport voltage.

B. **DC capacitance estimation**

This rating is calculated with DC bus capacitor equation 4 and 5 has been identifies the model of UPQMC

\[ PPV - UPQMC = C_{dc} \times 2w \times V_{dc} \times \Delta V_{dc} \]

Hence, \( C_{dc} = \frac{PPV - UPQMC}{2w \times V_{dc} \times \Delta V_{dc}} \)

\[ = \frac{1150}{2 \times 314.1 \times 450 \times 5} \]

\[ = 4.7 \text{ mF} \]

C. **Rating of sequence inverter**

\[ V_{SE} = X \times V_{SE} \]

\[ = 230 \times 0.3 = 69 \text{V} \]

\[ K_{se} = \frac{V_{SE}}{V_{SE} - 69} \]

\[ = \frac{69}{3.23} = 3.3 \approx 3 \]

The equation 5 & 6 is the calculations of voltage ratings like \( V_{SE} \) and \( K_{se} \) additionally harmonics has been adjusted for damage reduction related to home and industrial applications.
Eqn7 explains that series power estimation which is calculated from fig5.

### D. Shunt & Series Inductance

The currents of DC interface, swell energy, exchanging recurrence remain the elements on behalf of choosing the inductor in shunt INV.

\[
I_{sh} = \frac{V_{dc} \times m}{4 \times \alpha \times f_{dc} \times I_{tp}}
\]

\[
= \frac{450 \times 1}{4 \times 1.2 \times 1000 \times 3.1} = 3.02 \text{ mH} \quad \text{(8)}
\]

\[
I_{se} = \frac{K_{se} \times V_{dc} \times m}{4 \times \alpha \times f_{se} \times I_{tp}}
\]

\[
= \frac{3 \times 450 \times 1}{4 \times 1.2 \times 1000 \times 3.1} = 9.07 \text{ mH} \quad \text{(9)}
\]

In above equation 8&9 demonstrate that inductance adjustment and series current controlling by LH scenario. In every assessment continuous monitoring of power, current, voltage are estimated by swag and swell positions.

### E. Solar Panel

Relating KCL to the overhead circuit,

\[
I_{ph} = ID + I_{sh} + I \quad \text{(10)}
\]

Commencing (9), we change to photovoltaic panel present

\[
I = I_{ph} - I_{0} - I_{sh}
\]

\[
= I_{ph} - I_{0} \left[ \exp \left( \frac{V_{ph} - V_{T}}{n_{a} \cdot I_{ph}} \right) - 1 \right] - \frac{V_{ph} - V_{T}}{n_{a} \cdot I_{ph}} \quad \text{(11)}
\]

\[
\text{Efficiency} = \left[ \frac{V_{mp} \cdot I_{mp}}{I (\text{m}^2)} \right] \cdot A (\text{m}^2) \quad \text{(12)}
\]

Eqn 10,11&12 explains about KCL current and photovoltaic cell panel current at final efficiency are calculated.

Wherever, Vmp= voltage at peak energy,

Imp= present at peak power,

I= Irradiation of solar energy,

A= solar radiance area

The conditions of PV array remain as track
\[ Vg ( ) + (Vs− ) (1 − D)Ts = 0 \quad \text{---------(12)} \]

Hence the output voltage can be obtained as,

\[ V_o = \frac{V_g}{(1 − D)} \quad \text{---------(13)} \]

<table>
<thead>
<tr>
<th>parameters</th>
<th>UPQMC-Module</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STC</td>
</tr>
<tr>
<td>Nominal Max. Power (Pmax)</td>
<td>374.5W</td>
</tr>
<tr>
<td>Opt. Operating Voltage (Vmp)</td>
<td>69V</td>
</tr>
<tr>
<td>Opt. Operating Current (Imp)</td>
<td>9.76A</td>
</tr>
<tr>
<td>Open Circuit Voltage (Voc)</td>
<td>49V</td>
</tr>
<tr>
<td>Short Circuit Current (Isc)</td>
<td>9.82A</td>
</tr>
<tr>
<td>Efficiency</td>
<td>19%</td>
</tr>
<tr>
<td>Temperature -</td>
<td>-40°C ~  +85°C</td>
</tr>
</tbody>
</table>

Table 1 UPQMC outputs

<table>
<thead>
<tr>
<th>JKM295p-Jinko solar</th>
<th>CS6U-Canadian solar</th>
<th>Vikram Solar</th>
<th>UPQMC-Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>STC</td>
<td>NOCT</td>
<td>STC</td>
<td>NOCT</td>
</tr>
<tr>
<td>Nominal Max. Power (Pmax)</td>
<td>295WP</td>
<td>218WP</td>
<td>340W</td>
</tr>
<tr>
<td>Opt. Operating Voltage (Vmp)</td>
<td>36.2V</td>
<td>33.5V</td>
<td>37.6V</td>
</tr>
<tr>
<td>Open Circuit Voltage (Voc)</td>
<td>45.1V</td>
<td>41.9V</td>
<td>45.9V</td>
</tr>
<tr>
<td>Module Efficiency</td>
<td>15.20%</td>
<td>15.20%</td>
<td>17.49%</td>
</tr>
<tr>
<td>Operating Temperature -</td>
<td>-40°C ~ -85°C</td>
<td>-40°C ~ -85°C</td>
<td>-40°C ~ -85°C</td>
</tr>
</tbody>
</table>

Table 2 Comparison of results

Table 1&2 explains that final outcomes related to existed implement 1. Jinko solar 2. Canadian solar 3. Vikram solar 4. UPQMC module. In this fourth method achieves good performance at all abnormal conditions. Using machine learning algorithms like Random Forest optimization techniques using decision trees methods increasing the efficiency and accuracy..

IV. RESULTS

Irradiance values to be varies drastically and apply this proposed UPQMC method find the power, voltage and different parameters variances, finally compares the results with existed methods

Fig 8 harmonic system with existed method
Fig. 8 demonstrates the electrical energy suspend in the framework, as the NON LINEAR weight is associated with the framework and observe the fluctuation. The energy is 375-400 V that is the power list has happened. The normal energy on behalf of solitary-stage supply is 375-475V. Consequently the voltage list is wiped out through arrangement inverter; by infusing the necessary power in PV incorporated UPQMC. Subsequently by settle up the energy droop the yield procured is 375-405 V, as appeared in fig. 9.

Comparing DC voltages of existing UPQC and proposed model in the below table. These results were taken by the simulation of the circuits implemented due to the change in time of simulation at different irradiance values shown in fig.10 and 11.

By using the proposed technique, the PQ, transient response, stability the system will be improved and also achieve the maximum power from PV. The dynamic behavior of voltage and current loops will be analyzed for
regulating the dc link voltage and the output inverter current. The THD of the system will be minimized under various irradiance conditions.

V. CONCLUSION

This paper demonstrates the exhibition of UPQMC by coordinating sunlight based PV board. Consequently the present harmonics and voltage levels are improved. The re-enactment is completed on power recreation and shunt transformer mode. In this, the general reproduction of control excellence conditioner coordinated through sun-powered PV. The outcomes consequences that removal of voltage swags and current harmonics with power quality. Normal power improved by 1.8%, normal voltage 43.47% enhanced, operating current attain by 1%, open circuit current by 0.14%, short circuit improve by 0.19%, efficiency by 0.145%. at -40\(^0\) and 85\(^0\)

REFERENCES

11. JKM295p-Jinko solar system design
12. CS6U-Canadian solar system.
13. Vikaram Solar system.