MPPT METHOD IN PV SYSTEM FOR GRID CONNECTION

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Abstract:

This Paper will provide high voltage gain with state model analysis for the control of the system has been presented. First the photovoltaic system is designed and simulated using MATLAB SIMULINK software. The output voltage of a PV array is comparatively low thus high voltage gain is necessary for grid-connection and synchronization. The PV system has been provided with a Boost Converter which will boost the low voltage of the PV array to high dc-voltage. A steady state model is obtained and is verified with the help of simulation. A full bridge inverter with bidirectional power flow is used as the second power processing stage, which stabilizes the dc voltage and the output current. Further, a Maximum-Power-Point-Tracking method is employed in the PV system to obtain a high performance.

Keywords: Photovoltaic system (PV), Maximum-Power-Point-Tracking (MPPT), Boost Converter, Pulse Width Modulation (PWM)

[1] INTRODUCTION

Amongst the renewable source of energy, the photovoltaic power systems are gaining popularity, with heavy demand in energy sector and to reduce environmental pollution around caused due to excess use non-renewable source of energy. Several system structures are designed for grid connected PV systems. Four different kinds of system configuration are used for grid connected PV power application: the centralized inverter system, the string inverter system, the multi-string inverter system and the module integrated inverter system.The main advantages of using a grid connected PV systems are: effect on the environment is low, the can be installed near to the consumer, thereby transmission lines losses can be saved, cost of maintenance in the generating system can be reduced as there are no moving parts, system's modularity will allow the installed capacity to expand and carbon-dioxide gases are not emitted to the environment. For small distributed generator system ,such as residential power utilization, all the above mentioned types of inverters system other than centralized inverter system are be used. The main problem in the design of the photovoltaic distributed generator system is to obtain high voltage gain. For a typical photovoltaic model, the open circuit voltage is about 20 V and the maximum power point (MPP) voltage is about 16 V whereas voltage of the utility grid is 220 V ac. Hence high voltage amplification is mandatory for grid synchronization and to achieve low total harmonic distortion (THD). In grid-connected PV system power electronics inverters are used for the power conversion, interconnection and control optimization. The steady state analysis and control strategy of the system play a vital role in the grid synchronization. The output of the inverter should be properly sinusoidal for proper grid synchronization. Hence it is clear that inverter required for PV system, high power factor, low THD, fast dynamic response on how the control strategy are adopted for grid inverters. Ensuring current injected into the grid with low harmonic content and maintain the pahse with the main voltage, the controller must be able to track down maximum power point tracking (MPPT) mechanism using perturb and observe (P&O) algorithm for the PV model which will cause all the available array power to be utilized. It is mandatory that the most of the solutions designed to attain the PV system tasks such as MPPT, in inverter and Power factor correction are employed at two different stages.

[2] WORKING PRINCIPLE OF PV SYSTEM

Vitality change in sun powered cells works of two vital steps. First and foremost, assimilation of light produces an electron gap pair. The electron and gap are then isolated by the structure of the gadget electrons to the negative terminal and openings to the positive terminal—subsequently creating electrical force. A perfect sun oriented cell is spoken to by a present source associated in parallel with a correcting diode, as indicated in the identical circuit of Figure 1. The relating I-V trademark is portrayed by the Shockley sun powered cell mathematical statement

$$I_L = I_D + I_{Sh} + I \qquad (1)$$

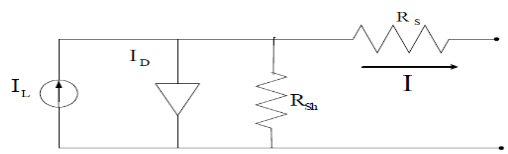


Fig-1. Equivalent circuit of a solar cell

The output of the solar cell i.e. the P-V and I-V curve is given in the following figure.

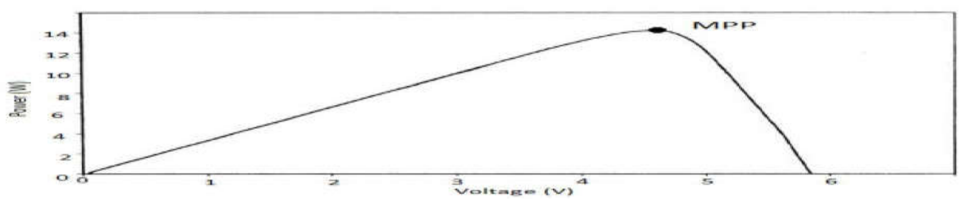


Fig-2. P-V Characteristics

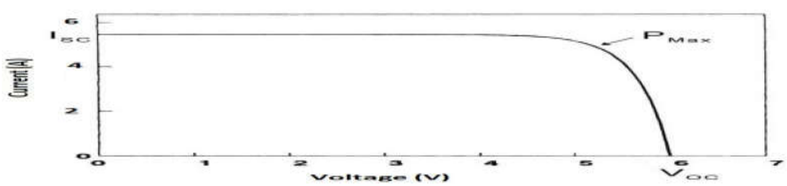


Fig-3. I-V Characteristics

[3]MAXIMUM POWER POINT TRACKING

The efficiency of a solar cell is low. With a specific end goal to expand the efficiency, routines are to be undertaken to match the source and load appropriately. One such strategy is the Maximum Power Point Tracking (MPPT). This procedure is utilized to acquire the most extreme conceivable force from a fluctuating source. In photovoltaic frameworks the I-V bend is non-direct, along these lines making it hard to be utilized to power a certain heap. This is finished by using a help converter whose duty cycle is differed by utilizing a mppt algorithm.

METHODS FOR MPPT

There are different methods to track down the maximum power point, a few of which are listed below:

- Perturb and Observe method
- Incremental Conductance method
- Parasitic Capacitance method
- Constant Voltage method
- Constant Current method

Perturb and Observe Method:

Perturb and Observe is the most regularly utilized MPPT strategy because of its simplicity of execution. The working voltage is expanded the length of (dP)/dV is sure, i.e. the voltage is expanded the length of we get more power. On the off chance that (dP)/dV is detected negative, the working voltage is diminished. The voltage is kept put if (dP)/dV is close to zero inside of a preset band. The time multifaceted nature of this calculation is less however on coming to near to the MPP it doesn't stop at the MPP and continues annoying. This calculation is not suitable when the variety in the sun oriented illumination is high. The voltage never really achieves a careful esteem yet annoys around the most extreme force point (MPP).

Incremental Conductance Method:

In this strategy the PV exhibit's incremental conductance dI/dV to figure the indication of dP/dV. At the point when dI/dV is equivalent and inverse to the estimation of dP/dV (where dP/dV=0) the calculation demonstrates that the greatest force point is come to and it is ended and gives back the comparing benefit of working voltage for MPP. This strategy tracks quickly changing illumination conditions more precisely than P&O.

Parasitic Capacitance Method:

This method is an improved version of the incremental conductance method, with the improvement being that the effect of the PV cell's parasitic union capacitance.

Constant Voltage Method:

This strategy is not broadly utilized as the misfortunes amid operation is subject to the connection between the open circuit voltage and the greatest influence point voltage. The proportion of these two voltages is for the most part consistent for a sun oriented cell, generally around 0.76. Consequently the open circuit voltage is acquired tentatively and the working voltage is acclimated to just 76%.

Constant Current Method:

It is like the consistent voltage technique, this strategy is subject to the connection between the open circuit current and the most extreme force point current. The proportion of these two streams is by and large consistent for a sun based cell, generally around 0.95. In this manner the short out current is acquired tentatively and the working current is acclimated to 95%.

Flowchart of MPPT Algorithm

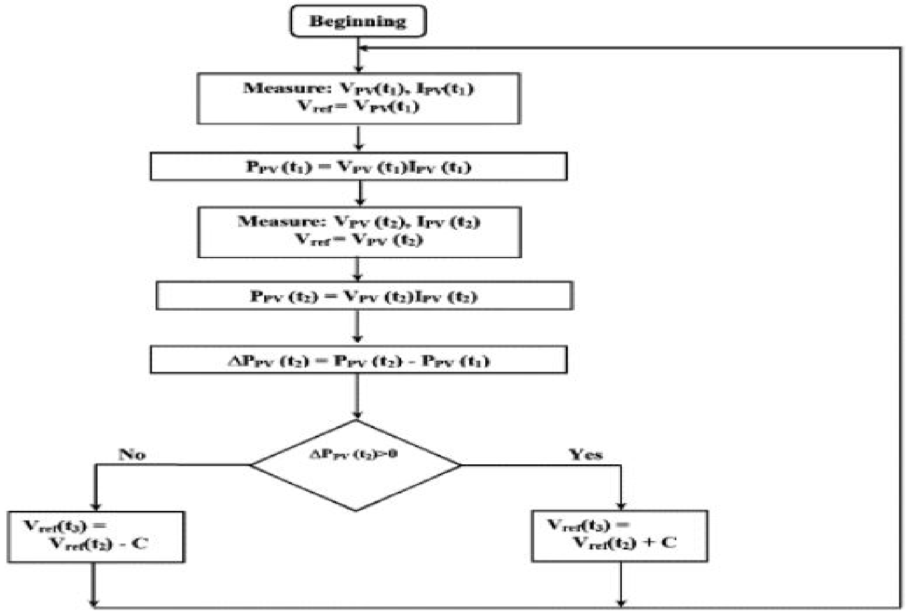


Fig-4. Flowchart of Perturb and Observe

[4] BOOST CONVERTER

As the output of the PV panel is very low and in order to connect it to the grid, its voltage has to be increased. The output of the solar panel is a DC voltage of very low magnitude. Hence a boost converter is required for boosting the voltage to higher level without use of the transformer. The primary parts of a support converter are an inductor, a diode and high recurrence switch. These in a composed way supply energy to the heap at a voltage more prominent than the information voltage extent. One capacitor is joined over the heap end to keep up the heap voltage consistent.

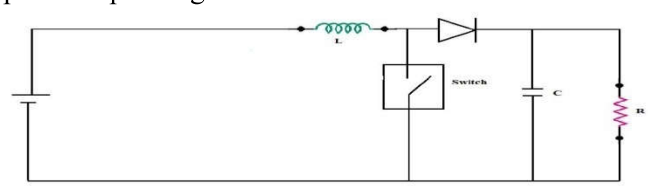


Fig-5. A boost Converter

[6]GRID SYNCHRONIZATION TECHNIQUE

Synchronizations method can be divided into two categories: namely mathematical analysis and PLL based methods. Among them, PLL method is gaining more attention.
A basic PLL consists of a phase detector (PD), a loop filter (LF) and a voltage controlled oscillator (VCO) as shown in fig-6.

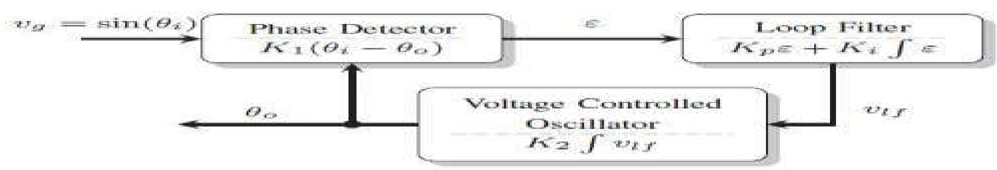


Fig-6. Structure of a PLL

$$\frac{\theta_0(s)}{\theta_i(s)} = \frac{K_1 K_2 G_{lf}(s)}{s + K_1 K_2 G_{lf}(s)} = \frac{K_1 K_2 K_p s + K_1 K_2 K_i}{s^2 + K_1 K_2 K_p s + K_1 K_2 K_i} \quad ($$

Where, θ_0, θ_i are output and input phases

K_1,K_2 are the gains of PD and VCO respectively. $G_{lf}(s)$=
$K_p + K_i/s$ is LF transfer function.
K_p,K_i are proportional and integral gains of LF.

The various kinds of PLL techniques are:

1. Linear PLL

Linear PLL (LPLL) is predominantly utilized for single stage voltage. It has a blender which is utilized as a stage differentiator which gives a sign relative to the contrast between the periods of the data and the yield signal. This mistake sign contains parts at frequencies which are even products of the info recurrence. The circle channel evacuates the consonant parts and just the corresponding segment is gone on to the voltage controlled oscillator as per which the VCO yield is created.

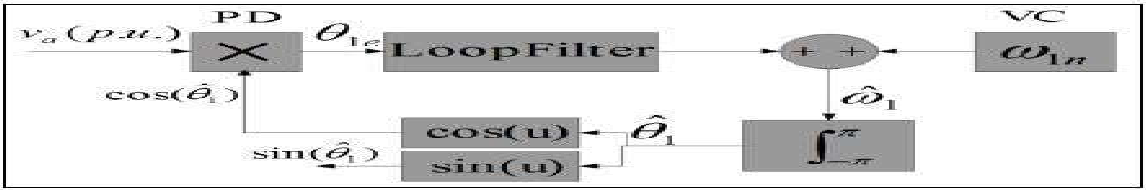


Fig-7. Block diagram of LPLL

2.Synchronous Reference frame PLL

A synchronous Reference Frame PLL (SRF PLL) is utilized for following the stage point if there should arise an occurrence of 3-stage signals which meets expectations in a comparable manner as a direct PLL with just distinction in the Phase Detector (PD) piece. It uses Park's Transformation of a 3-stage motion as the PD. Fig 8 demonstrates the piece outline of a SRF PLL in which Va, Vb, Vc are the parts of a 3- stage signal. To begin with square in the figure is Clarke's Transformation which deciphers a 3-stage voltage vector from the abc common reference edge to the αβ stationary reference outline. The second square is the Park's Transformation which deciphers the αβ stationary reference edge to turning rotating frame.

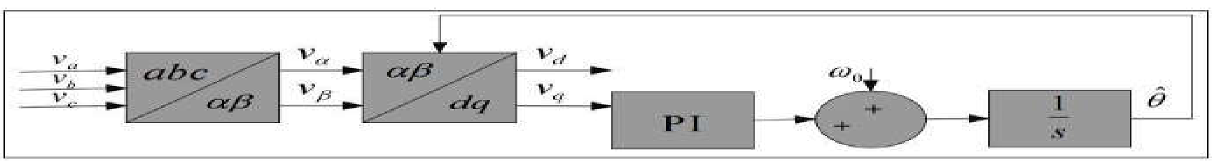
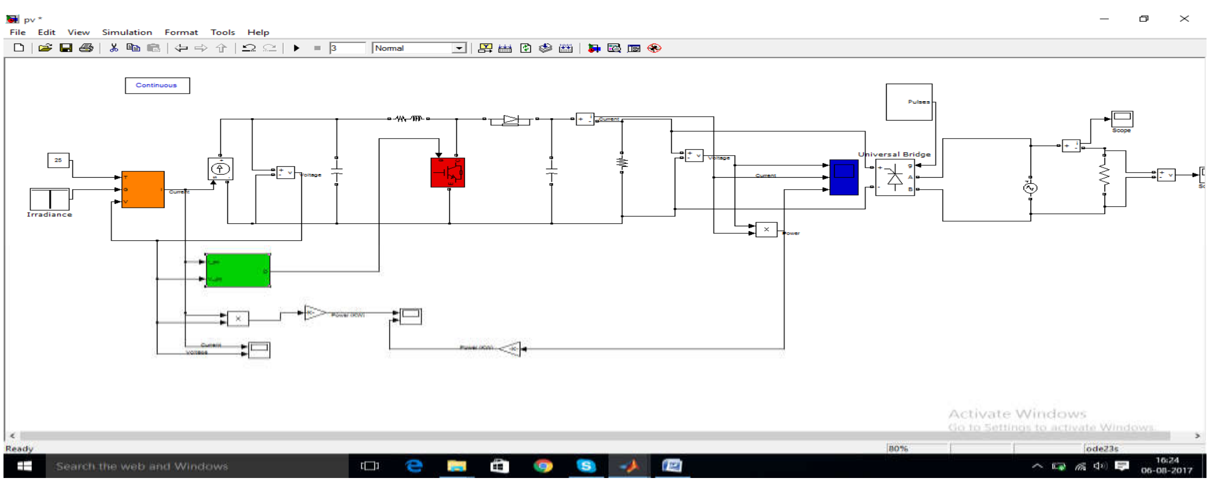
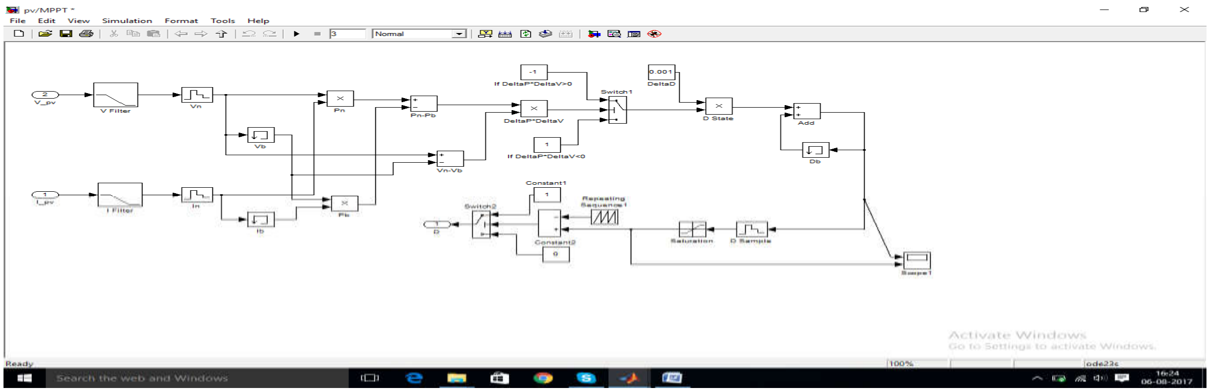


Fig-8. Block Diagram of SRF PLL.

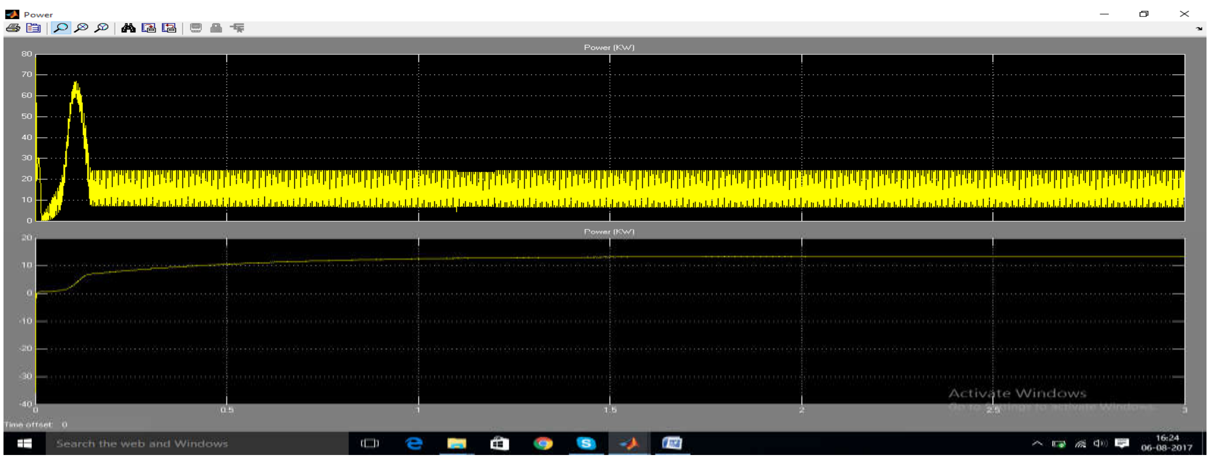
[7]MATLAB CIRCUIT AND SIMULATION RESULTS



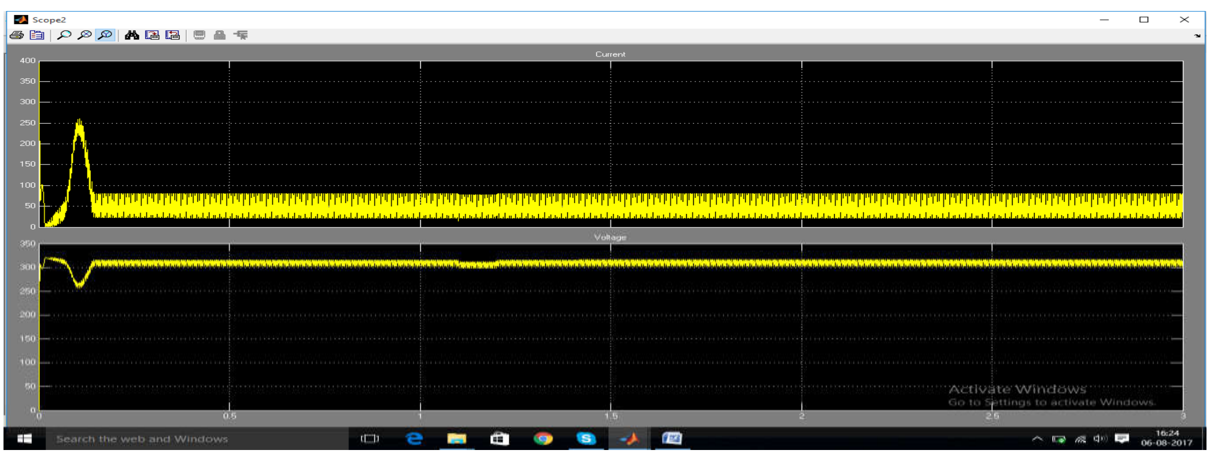
Main ckt



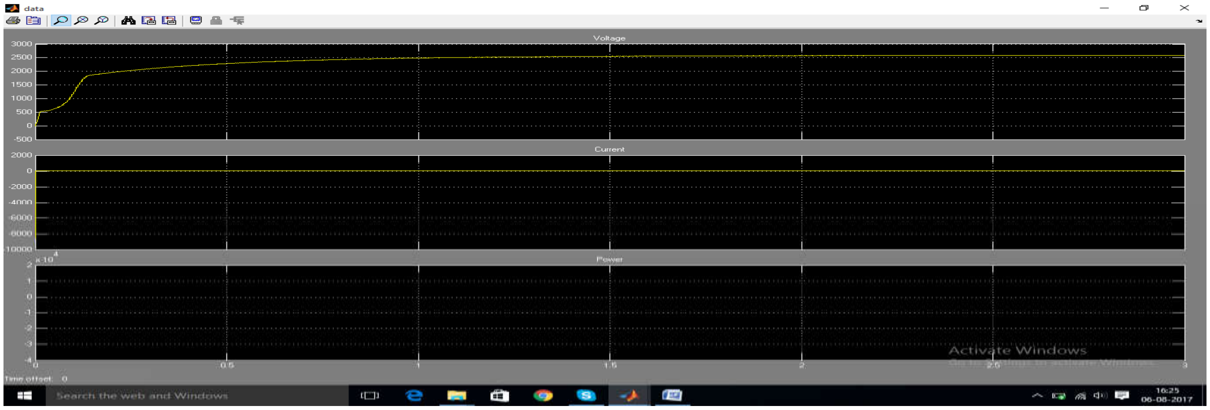
Mppt technique



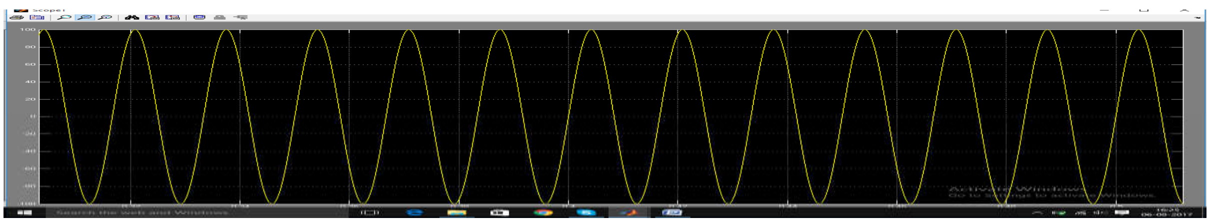
Power with and without mppt



Voltage and current without mppt



Voltage and current and power with mppt



Grid voltage

Grid current

[9] CONCLUSION

A PWM generator was utilized for generating the pulse signal that was compared with the signal generated from the MPPT unit to give out the gating signal to the switch.If MPPT had not been used, then the user would have had to input the duty cycle to the system. When there is change in the solar irradiation the maximum power point changes and thus the required duty cycle for the operation of the model also changes. But if constant duty cycle is used then maximum power point cannot be tracked and thus the system is less efficient.The various waveforms were obtained by using the plot mechanism in MATLAB. There is a small loss of power from the solar panel side to the boost converter output side. This can attributed to the switching losses and the losses in the inductor and capacitor of the boost converter.The parameters of the inverter model like the inductance, the dc gain (kv) and time constant (tv) considerably affect the system dynamics at the switching time and should be chosen properly to obtain a stable periodic behavior. When instead of PV, DC source is connected the voltage waveform is quite similar to the reference voltage but both current and voltage has some harmonic content in them. After connecting the PV module the harmonic content in current and voltage increased and the output of the PV was also affected considerably.

A Linear PLL (LPLL) is used for synchronization for single phase signals with acceptable results and a Synchronous Reference Frame (SRF) PLL is used for 3-phase balanced signals. But it cannot be used for unbalanced utility conditions as the detected phase angle contains 2nd harmonic oscillations.

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