Single Phase Single Stage grid connected PV system

Mukesh Mishra
Swami viveakanad subharti university,Meerut U.P (India)

Durgesh kumar
Swami viveakanad subharti university, Meerut U.P (India)

Jaysing A. Kshirsagar
Dr. Babasaheb Ambedkar Technological University Lonere(India).

Abstract:- The electricity sector have many quandary regarding, the supply of electricity, so renewable energy promotion policies have increase the solar energy consumption. The consequential of photovoltaic cell connected to the grids. These papers propose the single stage inverter with maximum power point tracking (MPPT) and one cycle controlled (OCC) for grid connected PV system. One cycle controlled scheme is predicated on the output current adjustment .Schemes predicated on one-cycle control (OCC) which do not require the accommodation of a phase locked loop for interfacing the inverter to the grid are increasingly being employed for such applications. It requires less no. of sensors (two) as compared to that required (four) in the earlier reported scheme for the implementation of the core controller comprising of OCC and MPPT blocks. The maximum power extracted from the PV array we are Peterman and observation method.

Keywords— *One Cycle Control (OCC); Maximum Power Point Tracking (MPPT); Photovoltaic (PV) array; Single phase grid connected inverter.*

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I. INTRODUCTION

The rapid increase in the industrial area, the fossil fuel consumption is increase day by day. Rapid increase in pollution in the environment it increments in ecumenical warming and damage ecological. Due to these there is need to increment the utilization of renewable energy in the environment, there are many renewable energy in the environment such as wind, tidal solar and etc. Among all these renewable energy solar energy is obtainable yarely so that the ordinant dictation for photovoltaic (PV) panel has been incrementing more and more. The output voltage and current of a PV panel vary with irradiation, panel temperature and power loading nonlinearly. Under certain atmospheric condition, there subsists a maximum power point. To draw maximum power from PV panel, a sizably voluminous number of researchers have proposed maximum power point tracking (MPPT) algorithms such as voltage feedback method [1]. In these papers we are discussing about photovoltaic cell connected to the grid.

A grid connected PV system has become very popular because of their application in distributed generation and for efficaciously utilizing the PV array potency. The symbolic grid –connected system is shown in fig 1.

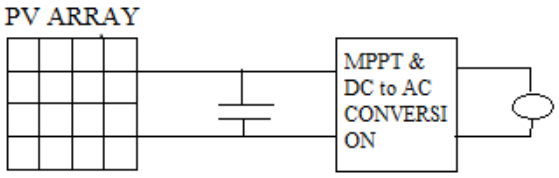


Fig.1 A generic grid connected PV system.

A grid connected PV system has many power processing stages [2], [3].The first stage is dc –dc conversion which extract maximum power by utilizing a maximum power point tracking (MPPT).the second stage is inverting the dc to a A.C conversion and then aliment to the grid .the output of this stage is then inverted by utilizing the inverter. The inverter ascertains that whatever amount of potency is extracted from the solar array is being dumped on the grid which is achieved by maintaining the dc-link voltage at a set reference. Like two stage systems, the single stage inverter performs two functions: 1) obtaining maximum power by utilizing congruous MPPT algorithm .2) these potencies are distributed to the grid by maintaining felicitous power quality discipline of the utility. The grid connected pv system consist of two current control loop, An expeditious inner current controller regulates the current injected to the grid while maintaining prescribed total harmonic distortion (THD) and power factor, while a slow outer current-control loop incorporates the MPPT algorithm employed. When interfacing PV system to grid, it

required phase lock loop (PLL). Designing a PLL for interfacing with an impotent grid is always an arduous proposition considering the non idealities like frequency variation and harmonic distortions present in the line voltages [4]. The system base on OCC does not require the accommodation of PLL [5]-[7].

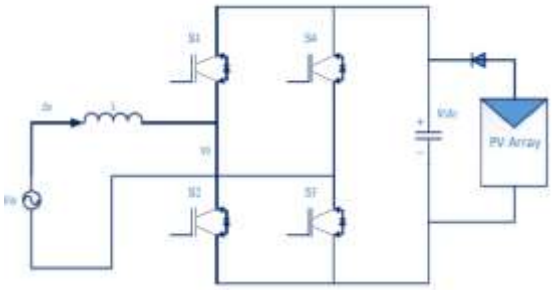


Fig.2 1Ø single stage grid connected pv system

Due to the current control loop the operation become faster.

A single stage single phase one cycle controlled base grid connected pv system can operate at maximum power point tracking. For obtaining maximum power occ is using perturb and observed method at maximum operating power point.

II. VOLTAGE-SENSORLESS OCC BASED INVERTER for PV SYSTEM

A single-stage grid-connected PV system having a singlephase full-bridge voltage source inverter is shown in Fig. 1. The inverter switches are controlled to engender an output voltage from the inverter whose fundamental component is VI1. By controlling the magnitude and phase of VI1 through a congruous pulsewidth-modulation strategy, the puissance flow from the solar array to the grid can be controlled while maintaining a high power factor and low harmonic distortion. Considering the phasor model of the system shown in Fig. 2 and postulating the system to be lossless, the expression for authentic power flow from the inverter to the grid can be expressed as follows:

$$P = \frac{VI_1V_S Sin\delta}{\omega L} \qquad (1)$$

where V_S is the rms grid voltage, ω is the grid frequency, and δ is the phase angle between the fundamental component of the output voltage of the inverter and the grid voltage. The inverter, however, cannot be controlled with the fundamental OCC-predicated control technique as rudimental OCC-predicated schemes exhibit instability in operation when the converter involved is operated in an inverting mode of operation [8], [9]. In order to surmount this quandary, a modified OCC(M-OCC)- predicated scheme has been reported in [22]. Albeit the scheme presented in [8] does not require the accommodation of a PLL, it needs to sense instantaneous grid voltage kindred to the case of [4]. In the scheme reported in [8], the sensed grid voltage is multiplied by a constant gain to engender a fictitious current signal if in phase with the grid voltage. This fictitious current signal is then integrated to the authentic current drawn by the inverter. The sum of these two signals is then utilized by the OCC core controller to engender gating pulses for the inverter switches.

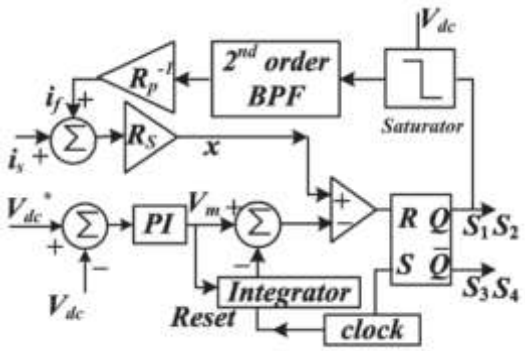


Fig.3.control block diagram of voltage sensorless grid connected pv system

The scheme proposed in this paper does not sense the grid voltage to engender the fictitious current signal required to circumvent the issue of instability in OCC-predicated inverter. It synthesizes the fictitious current signal required by multiplying the fundamental component of the inverter output voltage with a constant gain. Information regarding the inverter output voltage is obtained from the switching function used to trigger the inverter switches and not by sensing the inverter output voltage per se. The schematic control block diagram of the proposed scheme is shown in Fig. 3. The dc-link capacitor voltage is sensed and compared with a set reference, and the error so engendered is alimented to a proportional and integral regulator to engender a signal Vm. A sawtooth waveform of constant frequency having a peak-to-peak

value of 2Vm is engendered utilizing a resettable integrator. A free-running clock having a duration Ts is utilized to reset the integrator, and hence, the frequency of the clock T−1 s decides the frequency of the sawtooth waveform as well as the switching frequency of the contrivances. The time constant of the integrator Ti is opted to be a moiety of Ts as expounded in [6]. A fictitious current signal proportional to the fundamental component of the output voltage of the inverter (if = VI1/Rp) is integrated with the source current and opportunely scaled to obtain the modulating signal x, where

$$X=I_S + I_F = I_S + \frac{V_I}{R_P} \qquad (2)$$

In order to obtain VI1 and hence if , inverter switching pulses are passed through a saturator. The output of the saturator pulsates between the scaled dc-link voltage (Vdc) and zero in tandem with the pulsation of the switching sequence between the states one and zero. The signal proportional to VI1 is obtained by filtering the output of the saturator. The harmonic spectrum of the saturator output has: 1) a fundamental frequency component (50 Hz); 2) a dc component; and 3) higher frequency components centered around multiples of switching frequency. Hence, a band pass filter (BPF) is required to retrieve the fundamental component of this signal and filter out the dc and higher order components. A second-order BPF having a central frequency identically tantamount to the puissance frequency (50 Hz) is utilized for the purport. The circuit diagram of the second-order filter is shown in Fig. 4. The modulating signal is multiplied by a gain Rs and is then compared with the sawtooth waveform to engender the switching pulses. At every elevating edge of the clock pulse, S3 and S4 are turned on which leads to the increment

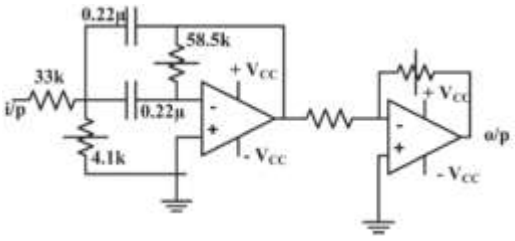


Fig. 4-Circuit diagram of analog implimentaion of BPF

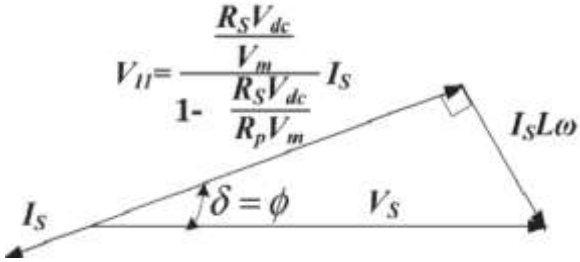


Fig.5-Phasor diagram depicting the steady-state comportment of the proposed voltage-sensor less system.

in source current is. When the modulating signal becomes identically tantamount to the sawtooth waveform, S3 and S4 are turned off and S1 and S2 are turned on so that the modulating signal and hence is decrease. The elevating and falling slopes of is are given by (vs + Vdc)/L and (vs − Vdc)/L, respectively, where vs is utility voltage, Vdc is the dc-link capacitor voltage, and L is the magnitude of the boost inductor. The modulating signal x is being compared with the sawtooth waveform to engender the switching pulses. When x is less than the sawtooth waveform, S3 and S4 are on, and the output voltage of the inverter is −Vdc. When x is more preponderant than the sawtooth waveform, S1 and S2 are turned on, and the output voltage of the inverter is +Vdc. Hence, the average output voltage of the inverter during a switching duration (time period of the sawtooth waveform) is

$$V_M=\frac{V_M-X}{2V_M}(-V_{dc}) + \frac{V_M+X}{2V_M}(V_{dc})=\frac{V_{dc}}{V_m} \qquad 3$$

Therefore, it can be inferred from (3) that the average inverter output voltage in a switching duration is proportional to the modulating signal x. Further, the fundamental component of the output voltage of the inverter will be in phase with the modulating signal. By coalescing (2) and (3), the expression for the inverter output voltage averaged over a switching time period is obtained as follows:

$$V_M=\frac{R_S V_{dc}}{V_M}(I_S + \frac{V_I}{R_P}) \qquad 4$$

From the aforementioned expression, it can be inferred that Vi and is are having a phase shift of either 0◦ or 180◦ between each other. The phasor diagram exhibiting the grid voltage, the fundamental component of the inverter output voltage, and the drop

across the series filter inductance is depicted in Fig. 5 for the inverting mode of operation.

III. MPPT IMPLEMENTATION USING P&O METHOD

P&O method is one of the popular methods to track the maximum-power point [10]. Implementation ofMPPT by P&O method is generally done by utilizing DSP or microcomputer, but discrete analog and digital

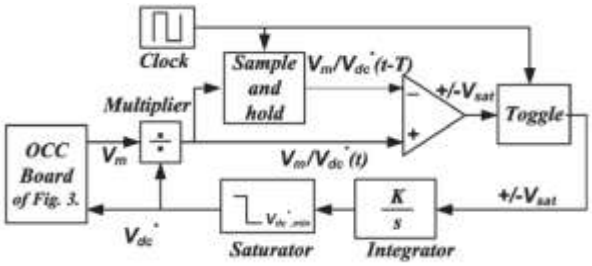


Fig. 5.block diagram of mppt realization

circuitry can withal be utilized for the purport [11]. The analog controller proposed in this paper for the implementation of the P&O algorithm is shown in Fig. 8. The controller consists of an analog multiplier, a sample and- hold circuit, a free-running clock, a toggle switch, and an integrator. The P&O controller receives the signal Vm from the OCC controller of Fig. 3. The output of the P&O controller is Vdc^* which sets dc-link voltage reference required by the OCC controller of Fig. 3. An integrator connected to the output of a toggle flip-flop engenders the voltage reference Vdc^*. The period of the P&O cycle is decided by a free-running clock which sets sampling instants for the sample-and-hold circuit and toggling instants for the toggle flip-flop. In order to understand the working of the MPPT controller, the typical variations of the different signals of the MPPT controller block are shown in Fig. 9. Depending on the output level of the toggle flip-flop, Vdc^* can have either a elevating or a falling slope. The rate of vicissitude in Vdc^* is kept much more minute than the control bandwidth of the OCC controller. An analog multiplier of low bandwidth

IV. SIMULATION AND EXPERIMENTAL RESULTS

Simulated Performance

In order to prognosticate the performance of the proposed one cycle-controlled voltage-sensorless grid-connected system, detailed simulation studies are carried out on MATLAB– Simulink platform. In order to objectively show that the proposed voltage sensorless scheme does not have the quandary of current instability while operating in the inverting mode of operation, a model of the system shown in Fig. 1 is simulated [12]. The parameters the inverter culled for the purport of simulation [12] and the controller are as follows:

1) switching frequency: 20 kHz;

2) dc-link capacitor: 2200 μF;

3) series inductor: 2 mH;

4) Rp: 1.5 Ω

The designations for the solar array utilized in the simulation study are provided in Table I, corresponding to 1000W/m2 and 800W/m2 insolation levels. The dc-link reference is externally set at 220 V. The grid considered as a 230 Vrms 50-Hz system.

Table I

PV ARRAY SPECIFICATIONS

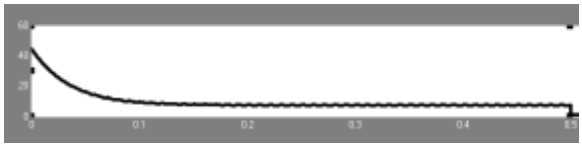
Peak power(P_P)	2KW	1.5KW
Peak power voltage(V_{MP})	220V	188V
Current at peak power (I_{mp})	8.8A	6A
Open circuit voltage(V_{OC})	230V	195V
Solar iosaltion	1000W/M^2	800W/M^2

When isolation level abruptly transmuted from 1000W/m2 to 800W/m2. The DC link voltage is suddenly fall at 188V and current is transmuted from 8.8A to 6A. And maximum power output of PV array is transmuted from 2kw to 1.5kw at 3 sec. After 8 sec, the voltage, current, power is settle back to the initial value. When isolation level abruptly transmuted from

1000W/m2 to 800W/m2. The DC link voltage is suddenly fall at 188V and current is transmuted from 8.8A to 6A. And maximum power output of PV array is transmuted from 2kw to 1.5kw at 3Sec.After 8 sec, the voltage, current, power is settle back to the initial value. Fig. (5) Shows the Simulation results such as waveforms of the DC link voltage, Grid current, and Grid voltage abruptly transmuted from 1000W/m2 to 800W/m2. The DC link voltage is suddenly fall at 188V and current is transmuted from 8.8A to 6A. And maximum power output of PV array is transmuted from 2kw to 1.5kw at 3 sec.

Dc link voltage

Dc link current



Grid voltage

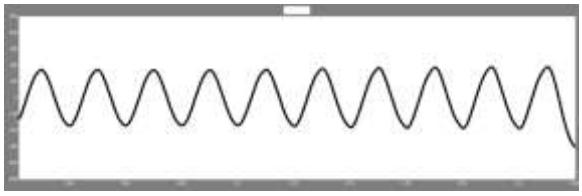


Fig. show the a)dc link voltage b)dc link current c)grid voltage.

From the simulated performance, it can be inferred that the system supplies the available maximum power from the PV array to the grid. The transient performance of the system can be optically discerned during the vicissitude in insolation levels. Moreover, it can be observed from the simulated performance that the vicissitudes in PV current and dc-link voltage are smooth during the transmutation in insolation level which implicatively insinuates a copacetic transient performance for the system. The steady-state grid voltage, source current, dc-link voltage, and the fictitious current signal obtained from the filtered output of the switching pulses of the inverter are shown in Fig. 5. It can be noted that the grid voltage and source current are virtually 1800 out of phase thereby demonstrating the inverting mode of operation. The quantified harmonic spectrum of the current supplied by the system to the grid and the grid voltage from which it can be inferred that all the low order harmonics to that of the fundamental component. As an OCC-predicated scheme poses itself as equipollent impedance to the grid, distortions present in the grid voltage withal appear in the current drawn by the system from the grid.

V. CONCLUTION

An M-OCC predicated Single phase Single stage voltage preposterous grid connected PV system has been proposed. The circumscription of the subsisting OCC predicated inverters, such as requisite for sensing the grid voltage to tackle the instability quandary, is circumvented in the proposed scheme. The proposed scheme is predicated on a single stage of potency con version and is realized by utilizing a considerably less number of sensors compared to that of conventional schemes. Further, the core controller of the proposed scheme can be realized by designates of a very simple analog controller. All the aforementioned features of the scheme make it an ideal candidate for minuscule and distributed single-phase grid connected PV systems. Detailed simulation studies have been carried out to verify the efficacy of the scheme. The viability of the scheme has been corroborated by performing detailed simulation studies.

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