2009년도 대한전기학회 하계학술대회 논문집 2009. 7. 14 - 17

계통 연계형 태양광발전시스템을 위한 POS MPPT 운전특성 최적화 기법

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Optimization technique of POS MPPT operational characteristics for grid-connected PV generation system

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Abstract - PV (Photovoltaic) power generation system has been widely studied as a clean and renewable power source. Tracking the MPP (maximum power point) of a PV array is usually an essential part of a PV system. This paper describes POS (Photovoltaic Output Sensorless) MPPT method and optimization technique of its operational characteristics for grid-connected PV generation system. A DC-DC converter has been used to step-up the PV voltage and DC-AC converter has been used for connecting the system to the grid. Optimization technique has been implemented to optimize the current and voltage controller gain parameters and duty ratio increment of DC-DC converter. Simulation results reveal that the proposed control has better response.

1. Introduction

Rapid advances in PV generation technologies have brought opportunities for increased utilization of solar energy for electric power generation around the world.

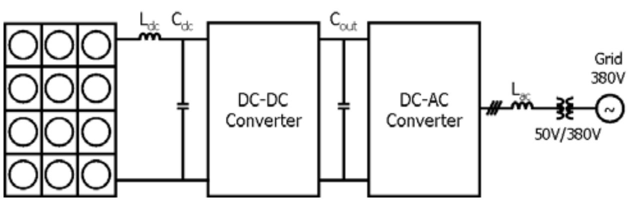
Tracking the maximum power point of a PV array is usually an essential part of a PV system. As such, many MPPT methods have been developed and implemented [1-3]. These methods vary in complexity, sensors required, convergence speed, cost, range of effectiveness, implementation hardware, popularity, and in other respects. In this paper, the authors focus on a POS control method which has no sensor on PV side [4].

This paper presents optimization technique of POS MPPT operational characteristics for grid-connected PV generation system. Details of the MPPT method and the simulation results are presented. MPPT controllers are designed to operate the DC-DC converter and a DC-AC converter is used to connect to grid.

2. System description and control

2.1 System description

The system diagram is shown in Fig. 1. The system parameters which are used to simulation are given in Table. 1. A boost converter is used as DC-DC converter and 3 phase transformer is used to connect to high voltage grid.



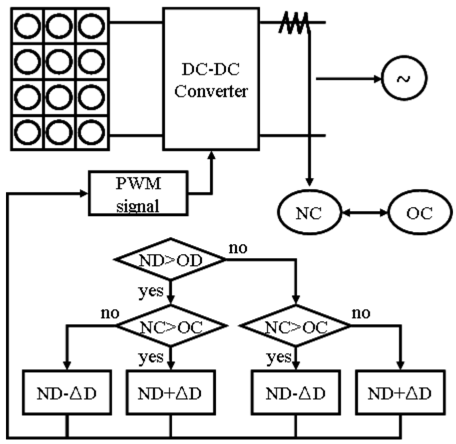
<Fig. 1> Electrical circuit diagram

<Table 1> System parameters

connection	V_{oc}	I_{sc}	V_{op}	I_{op}	Power
5*3	21.7[V]	3.37[A]	17.4[V]	3.05[A]	800[W]
L_{dc}	C_{dc}	C_{out}	L_{ac}	Switching devices	Utility
1[mH]	500[uF]	1000[uF]	5[mH]	IGBT	380[V] 60[Hz{

2.2 Control scheme

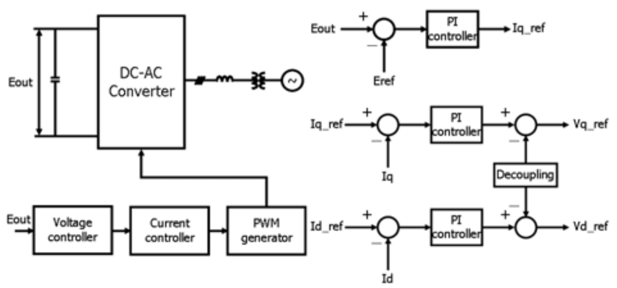
POS MPPT control method doesn't need any sensors at PV side as shown in Fig. 2. The DC-DC converter is used for getting the maximum power. This system is checking only the current of DC-DC converter output. According to duty ratio and current, new duty ratio has been decided for tracking maximum power point as shown in table 2. The duty ratio increment (ΔD) will be calculated using optimization. The MPPT control is activated every 50 msec.



<Fig. 2> POS MPPT block diagram (NC : New current, OC : Old current, ND : New duty, OD : Old duty)

<Table 2> A conceptual control table

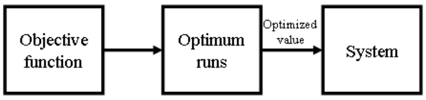
Case	Duty	Current	ΔDuty
1	(-)	(+)	(-)
2	(-)	(-)	(+)
3	(+)	(+)	(+)
4	(+)	(-)	(-)



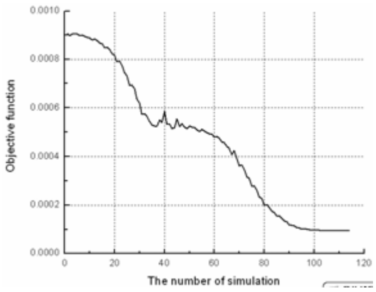
<Fig. 3> DC-AC Converter control scheme diagram

The voltage and current controllers have been implemented for DC-AC converter control. The block diagrams for the two controllers are shown in Fig. 3.

The optimum run approach can result in a huge time savings by drastically reducing the amount of runs required, as well as improving accuracy by converging to the exact design point. The nonlinear optimization program is given control to perform several consecutive runs with a view to minimize the desired objective function, which is computed from the results of each simulation run [5, 6]. During each run, an objective function is evaluated. Based on this objective function value, the optimization program then selects the parameter set to be used for the next run.



<Fig. 4> Optimization block diagram



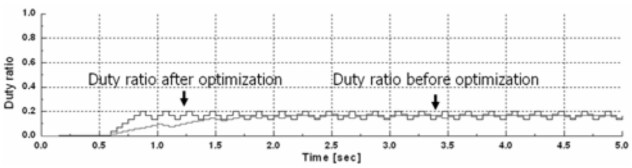
<Fig. 5> Objective function curve

In this paper, optimization technique has been implemented for voltage and current controller parameters. Because the response time of controllers should be fast. The optimization results are shown in table. 3. The block diagram is shown in Fig. 4. As same way, The duty ratio increment (ΔD) for MPPT control has also been optimized from 1% to 3.2%. In case of high duty ratio increment, it is fast but is fluctuating too much on maximum power point. So the optimization of duty ratio increment is required for satisfying both the conditions.

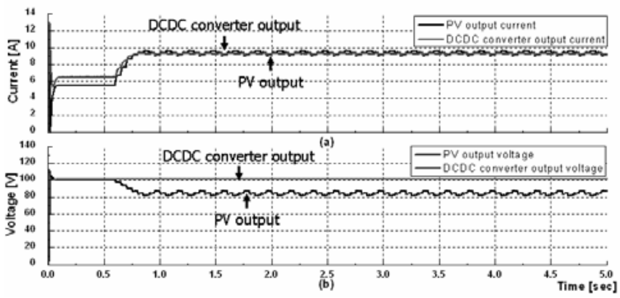
<Table 3> Comparison of controller gain parameters

Sort	VC		CC (Real)		CC (Reactive)	
	P1gain	T1const	P2gain	T2const	P3gain	T3const
Initial Value	1	0.1	100	10	100	10
Optimized Value	9.8	10.1	1199	618	693	398

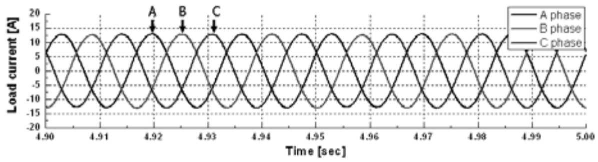
3. Simulation results



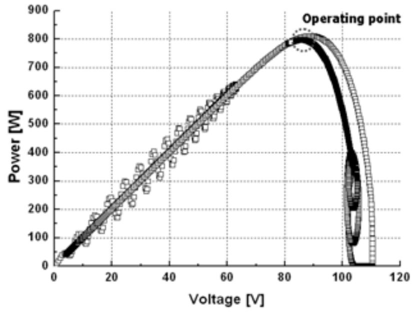
<Fig. 6> Comparison of results between before and after optimization



<Fig. 7> (a) PV and DC-DC converter output current, (b) PV and DC-DC converter output voltage.



<Fig. 8> 3 phase Load current.



<Fig. 9> PV curve.

The results show that the time to reach maximum power point is to be fast and fluctuation on the top is also not severe. The time is to be 0.8 sec. from 1.8 sec as shown in Fig. 6. Figure 7 represents current and voltage waveform of the converter input and output. The system is very fast to get MPP and stable. Figure 8 shows that the current coming out from inverter to grid is sinusoidal. The PV system is operating on maximum power point as shown in Fig. 9.

4. Conclusions

This paper discusses the optimization technique of POS MPPT operational characteristics for grid-connected PV generation system. A PV panel's power output depends on the solar radiation, which is quite unpredictable. Even if solar radiation is unpredictable, the proposed MPPT method can find out maximum power point of the PV system. The method of nonlinear optimization algorithms presented in this paper is a powerful tool for the design and operation of optimal systems.

Acknowledgements

This work is financially supported by the Ministry of Education and Human Resources Development (MOE), the Ministry of Commerce, Industry and Energy (MOCIE) and the Ministry of Labor (MOLAB) through the fostering project of the Industrial-Academic Cooperation Centered University.

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