LabVIEW와 DSP를 이용한 초저가 범용 태양광 발전시스템 VI-Tracer 개발

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Development of a Low Cost VI-Tracer for PV System using LabVIEW and DSP

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Abstract - This paper deals with development of a low cost VI(Voltage-Currrent)-tracer for PV(Photovoltaic) system using LabVIEW and DSP(Digital Signal Processor). Although the conventional VI-tracer is a high cost equipment, it can't abstract the detailed parameters of solar cell. To overcome above mentioned disadvantages, in this paper, a converter type VI-tracer is developed. The DSP, which controls the buck-boost DC-DC converter, is used to implement the proposed VI-tracer algorithm. The proposed VI-tracer can abstract more detailed parameters of solar cell; A(temperature constant), Rs(series resistance), and Rsh(parallel resistance). The authors emphasize that the proposed VI-tracer can satisfy the users who need to get various parameters. A comparison between the proposed VI-tracer and the conventional VI-tracer is presented to show the effectiveness of the proposed system.

1. Introduction

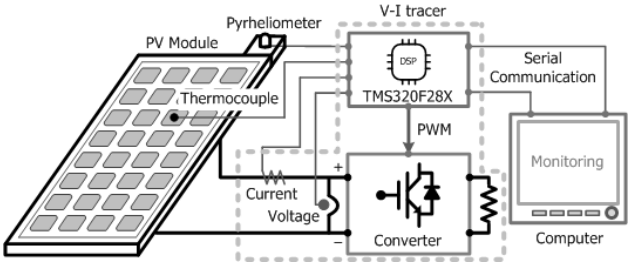
Quality inspection of solar cell under natural ambient conditions is a necessary service for users of photovoltaic equipment, considering a guarantee period of up to 10 years or even more. The principal task of photovoltaic measurement is to monitor the correct function of all components of a PV-system, to detect problem and to initiate maintenance and repair where necessary, otherwise defects will result in losses on energy yield [1]-[3].

The operating behavior of a solar cell is described by its VI characteristic. A reliable VI characteristic can be obtained with exact and detailed parameters of solar cell. However, the conventional VI-tracer can't abstract the detailed parameters of solar cell, although it is a high cost equipment.

In this paper, a converter-type VI-tracer is developed to reduce the overall system cost. Also the developed VI-tracer can abstract more detailed parameters of solar cell; A(temperature constant), Rs(series resistance), and Rsh(parallel resistance). A comparison made between the proposed VI-tracer and the conventional VI-tracer is presented to verify the effectiveness of proposed system [4]-[6].

2. Proposed VI-Tracer

2.1 Hardware composition



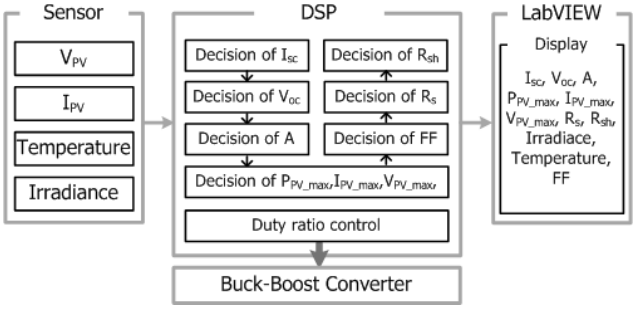
<Fig.1> Hardware composition of the proposed system

The proposed system with simple method to abstract PV parameters is composed of sensors for weather condition, OP amp, DC-DC converter, CT for current, PT for voltage, ADC(Analogto Digital Converter), and a personal computer(PC). Figure 1 shows the schematic diagram of hardware composition.

DC-DC converter works as the variable resistor connected up to the output terminal of PV module, and is automatically controlled by the DSP.

2.2 VI-tracer algorithm

Figure 2 shows the conceptual diagram of VI-tracer proposed in this paper. There are four input data; V_{PV}, I_{PV}, temperature, irradiance. As soon as the program starts, first of all, I_{sc} is settled. And, the program goes to the next step to decide V_{oc}. After deciding the detailed parameters; A, R_s, R_{sh}, the program finally gives users whole of the abstracted parameters [5].



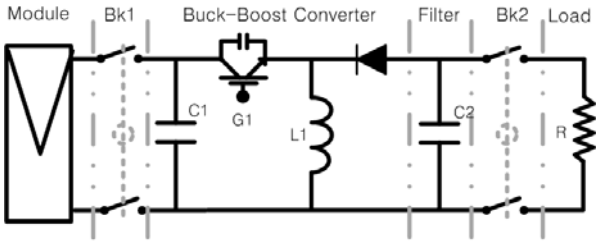
<Fig.2> The conceptual diagram of proposed system

3. Experiment results

A buck-boost DC-DC converter, which is controlled by DSP, is manufactured to implement the proposed VI-tracer.

Figure 3 shows the circuit diagram of manufactured DC-DC converter with the specifications shown in table 1. And Figure 4 represents the manufactured VI-tracer. In order to confirm the ability of the proposed VI-tracer, VI characteristic curve of the tested PV module was drawn by the obtained parameters via the proposed VI-tracer.

Figure 5 shows the V-I and V-P curves drawn by the parameters obtained from the proposed VI-tracer. Table 2 describes the comparison results between PV module specification and obtained parameters. The parameters obtained by the proposed system are correct with error of less than 5%.

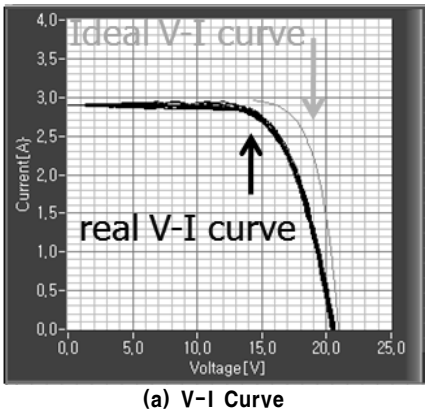


<Fig.3> Electrical circuit diagram of a manufactured DC-DC converter

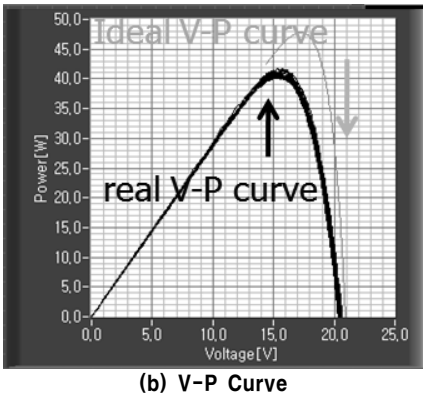
<Table 1> Specifications of DC-DC converter used for experiment

L_1	C_1	C_2	G_1	R
10mH	2200uF	2200uF	IGBT	1Ω

<Fig.4> The hardware configuration of the VI-tracer system



(a) V-I Curve



(b) V-P Curve

<Fig.5> Experiment results of VI-tracer

<Table 2> Comparison between PV module specification and obtained parameters

parameter	offered parameter	obtained parameters
V_{oc} at 25℃	21.6[V]	20.89[V]
I_{sc} at 1.0kW/m^2	3.25[A]	3.1[A]
A	×	0.0581
P_{mp}	50[W]	47.8[W]
V_{mp}	17.2[V]	17.27[V]
I_{mp}	2.92[A]	2.76[A]
R_s	×	0.078[Ω]
R_{sh}	×	1000[Ω]
FF	71[%]	79[%]

Table 3 shows performance comparison between commercialized conventional VI-tracer and developed VI-tracer in this paper. Most of the conventional VI-tracers can abstract the basic parameters. However, the proposed VI-tracer can abstract more detailed parameters. Thus using the DC-DC converter for VI-tracer results in more than 30% decrease of overall system cost.

<Table 3> Performance comparison between commercialized and developed VI-tracer

		Product A	Product B	Product C	Proposed VI-tracer
Abstracted parameters		V_{oc}, I_{sc}, V_{mp}, I_{mp}, FF, irradiance, cell temperature		V_{oc}, I_{sc}, V_{mp}, I_{mp}, FF, irradiance, cell temperature, At 1.0kW/m^2 and 25℃(V_{oc}, I_{sc}, V_{mp}, Imp), A, R_s, R_{sh}	
Cost(won)		8,000,000	70,000,000	More than 30,000,000	below 5,000,000
Measuring range	Voltage	10 to 600V	1 to 10V	1 to 250V	1 to 200V
	Current	1 to 20A	1 to 10A	1 to 40A	1 to 10A
	Power	10 to 10kW	1 to 500W	1 to 10kW	1 to 1kW
Manufacturing country		Japan	Japan	Germany	Korea

4. Conclusions

This paper deals with development of a low cost VI-tracer for PV system using LabVIEW and DSP. To reduce the overall system cost, in this paper, a converter type VI-tracer is developed. The DSP, which controls the buck-boost DC-DC converter, is used to implement the proposed VI-tracer algorithm. The authors expect that using the DC-DC converter for VI-tracer results in more than 30% decrease of overall system cost.

In addition, the proposed VI-tracer can abstract more detailed parameters of solar cell such as A, Rs, and Rsh. The parameters obtained by the proposed system are correct with error of less than 5%. The authors emphasize that the proposed VI-tracer can satisfy the users who need to get various parameters of solar cell.

Acknowledgements

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