The Study of Single Phase Source Stability consider for The DSC Cell's Operation Character by Controlled Feed-back Circuit

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Abstract—Recently, with increasing efficiency of DSC (photo-electrochemical using a nano-particle), The Performance of DSC solar generation system also needs improvement. The approach consists of a Fly-back DC-DC (transfer ratio 1:10) converter to boost the DSC cell voltage to 300VDC. The four switch (MOSFET) inverter is employed to produce 220V, 60Hz AC outputs. High performance, easy manufacturability, lower component count., safety and cost are addressed. Protection and diagnostic features form an important part of the design. Another highlight of the proposed design is the control strategy, which allows the inverter to adapt to the requirements of the load as well as the power source. A unique aspect of the design is the use of the DSP TMS320LF2406 to control the inverter by current and voltage feed-back. Efficient and smooth control of the power drawn from the DSC Cell is achieved by controlling the front end DC-DC converter in current mode.

Index Terms— Dye-sensitized solar cell(DSC), fly-back converter, full-bridge inverter, feed-back control, digital signal processor(DSP)

I. INTRODUCTION

Recently, with increasing concern about global environmental protection, the need to produce pollution-free natural energy has pointed us towards alternative sources of energy. Solar energy, especially, is a positive choice. The spread of residential photovoltaic (PV) systems connected with electric utility lines are being promoted in Korea. Among solar cells, DSC (dye-sensitized-solar cells) is a new class of low cost solar cells whose solar energy conversion efficiency is very high.

The power conversion and control device including a solar cell module and an inverter among components of photovoltaic power system have a great influence on its performance. In this paper, the characteristic of DSC solar energy generation system adapted MOSFET which is high-speed switching device and the DSP high-speed micro-processor, DSC solar energy generation system was simulated by PSIM. According to the result, we made the system and observed operation characteristic.

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II. EXPERIMENTAL PROCEDURE

A. Basic principle and preparation of DSC

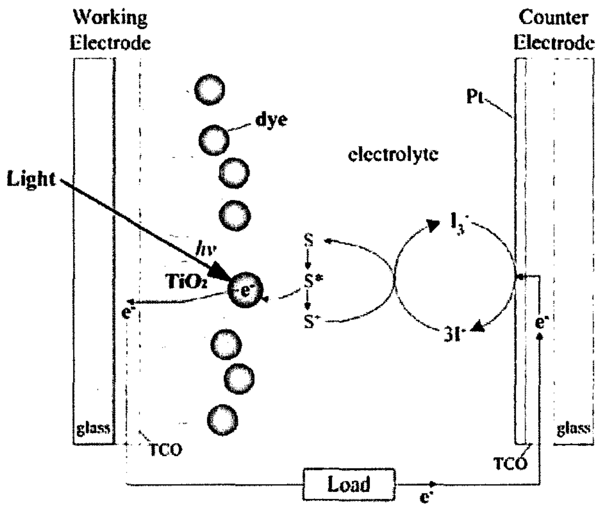


Fig. 1 Basic structure and principle of DSC.

Fundamental structure and working principle of the DSC is depicted in Fig. 1. DSC consists of two glass substrates, each of them coated with a transparent conducting oxide.

In the DSC, light is absorbed in a single layer of dye molecules. After light excitation, the dye molecule injects an electron into the TiO_2 film. The electron is diffused and transported to conductive glass through the TiO_2 surface by means of the diffusion and the trap-detrap process. The electron is filled at trap-site and is detrapped to conduction band. And then it is trapped again. The trap-detrap process works on the principle that the electron is diffused by repeating the previous steps.

It is collected and transferred through a load. The positive charge, formed in the light induced charge separation, is transferred from the dye to an electron donor mediator present in the cell electrolyte. Opposite of the TiO_2 film is the counter electrode, where the mediator is reduced into its original state by the electron collected at TiO_2 side of the cell.

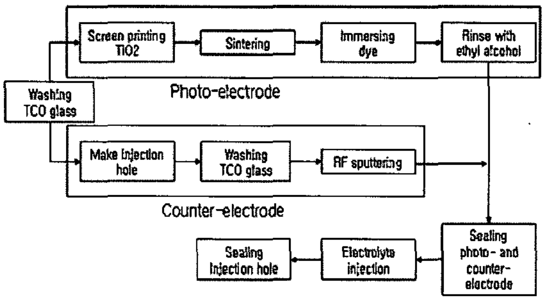


Fig. 2 Fabricating process of DSC.

An overview of all production steps of the cell preparation is shown in Fig. 2. In this study, DSCs were fabricated by next process as ITO glass is cleaned and prepared in advance. TiO_2 paste is coated on the ITO glass by screen printing method on it. And then it is fired at 450□to remove all organic components and to establish sufficient inter-particle contacts between the TiO_2 particles. The dye dissolved on ethanol is adsorbed on the nanoporous TiO_2 electrode film manufactured through the previous process. The Pt catalyst is coated by RF sputtering method. The working and counter electrode are sealed by the adhesive in a sandwich. The gap between two electrodes is filled with the electrolyte. Finally, the filling holes in the counter electrodes are closed with the adhesive. Fig. 3 shows the structure and appearance of DSCs.

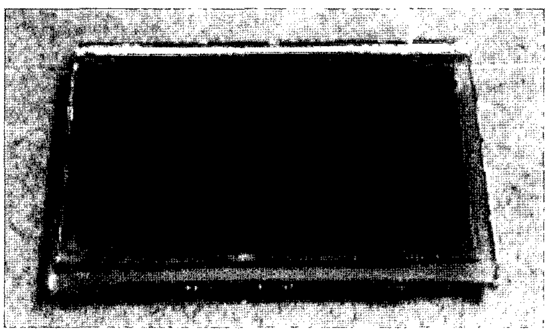


Fig. 3 fabricated DSC solar cell.

B. Inverter circuit and Simulation

We investigated DSC solar generating system in this paper. It is composed DSC cell, fly-back converter and PWM inverter as shown in Fig. 4. We used DSP and switched converter of 30kHz and PWM inverter of 30kHz. And we made up feed-back circuit in output part. And we identified stability of the output voltage and current value of alternating current which followed in input of DSC solar cell.

In order to confirm the stability of proposed DSC solar energy generation system in this paper, we make Fly-back converter, Full-Bridge PWM inverter and Feed-back circuit at output port. To show that stability of system was guaranteed by feed-back circuit.

The DC input from the DSC cell (30 VDC) is first converted to a regulated 300 VDC using a Fly-back DC-DC converter switching at 30 kHz. The DC-DC conversion stage consists of a high-frequency transformer. Isolation is provided for safety, system protection. The 300V DC-DC converter output is converted to 220V, 60 Hz, single-phase AC by means of a PWM driven inverter stage. To obtain independent single phase outputs, Full bridge inverters operating at 30 kHz switching frequency are used.

First, simulation was carried by ideal system configuration. Fig. 4 shows the main circuit that is used simulation. The main circuit was composed of transformer for boost voltage, 6 MOSFET and 6 FR(Fast Recovery) Diode. An output LC filter is used to harmonize the output voltage.

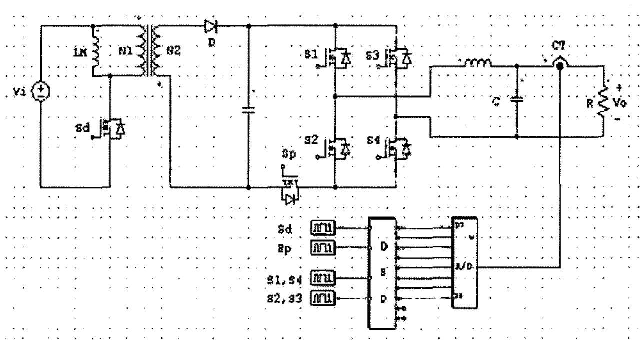


Fig. 4 Main circuit of PCS.

The controller was realized by used TMS320LF2406 because of dramatic increase in stability, has a good performance, faster design and build time.

The converter switches are operated at 50% ratio and 30kHz, the inverter PWM switches are operated at 30kHz. The switching signal S1, S4 of inverter full-bridge are operated at 60Hz and switching signal S2, S3 lag S1, S4 by 180°. The output signal data is obtained by sensing the current at output port. So A/D converter converts analog signal into 8bit digital signal.

The DSP receives this signal. It follows in error signal and controls the Switch Sd. It is a possibility of getting a stable output. The Fig. 5 shows showing the simulation waveform of output voltage and current. Like this figure, the output current of inverter with output voltage maintains same angles and it is supplied.

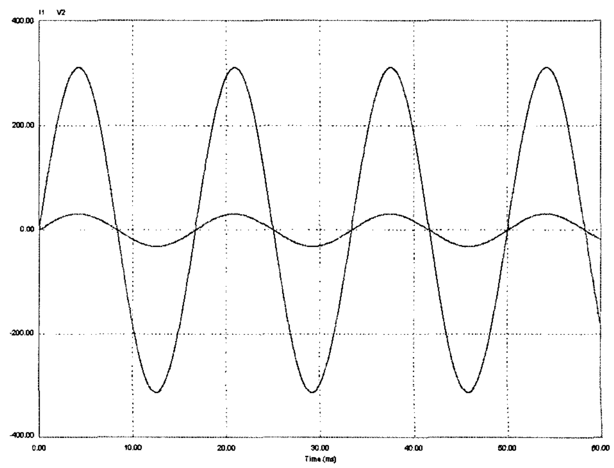
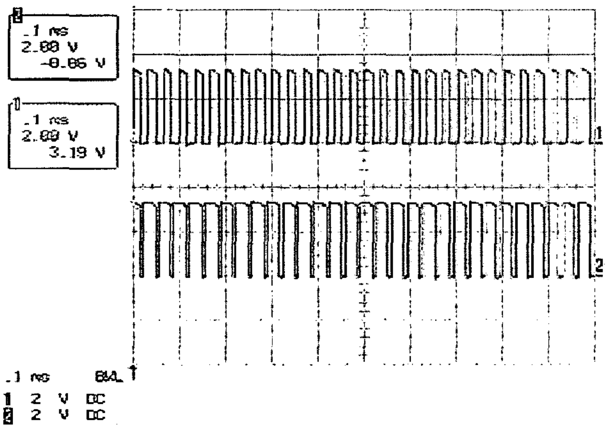


Fig. 5 Simulation waveform of output voltage and current.

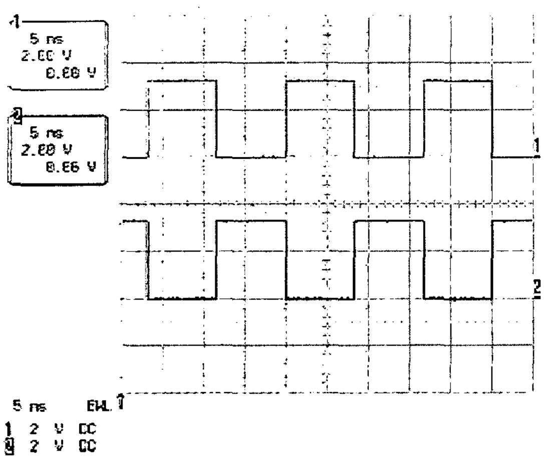
Consequently, in the systemic connection using this system, I estimate that it maintains power factor 1 and supplies a stable output. Also the delay of systemic power doesn't generate between output power of inverter and systemic power.

III. RESULT AND DISCUTION

Fig. 6 shows that the main switches operating. The converter switches are operated at 50% ratio and 30kHz, the inverter PWM switches are operated at 30kHz. The switching signal S1, S4 of inverter full-bridge are operated at 60Hz and switching signal S2, S3 lag S1, S4 by 180°.



(a)



(b)

Fig. 6 (a)Waveform of Full-Bridge Inverter S1, S4 andS2, S3 switching signal.
(b) Waveform of Flay-back switching signal.

Fig. 7 shows the output voltage and current wave in the DSC solar cell system without the feed-back circuit.

On the other hand, Fig. 8 shows the output voltage and current wave in the DSC solar cell system with the feed-back circuit. Fig 8 shows the efficiency of output power according to input power. We know that stable output was supplied.

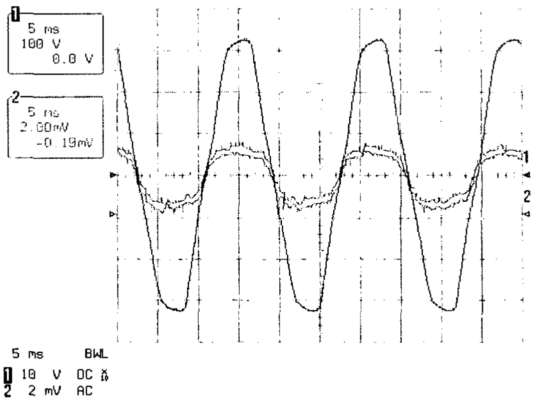


Fig. 7 Experimental waveform of output voltage and current without Feed-back circuit.

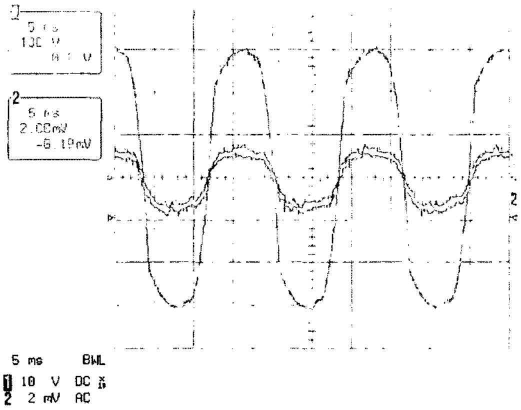


Fig. 8 Experimental waveform of output voltage and current with Feed-back circuit.

In conclusion, the DSC solar system with feed-back circuit has more stability of output than one without feed-back circuit. And the best efficiency of 90% for solar system with feedback-circuit was obtained at full load condition as shown in Fig. 9.

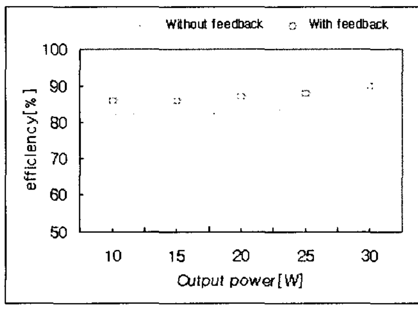


Fig. 9 The efficiency of output power according to input power.

IV. CONCLUSION

In this paper, We can see the propriety of the circuit that DSC solar energy generation system PWM PCS which uses the MOSFET is a high-speed switching device and the DSP micro processor and adapted feed-back circuit.

1) Gate signal of the MOSFET it applied the DSP, It was confirmed that the PCS was stable operated at switching frequency 30kHz by PSIM simulation and experiment.

2) The change of DSC output and current of load port adjusts by Feed-back circuit, The PCS's efficiency is improved about 5% and the stability is improved.

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