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Design of a Photovoltaic DC Power Supply System for Outdoor Controller Equipment

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Abstract: A photovoltaic DC power supply system for outdoor controller equipment was designed and developed in this paper. The power supply used dedicated chips design, which has characteristics of stable and reliable. The power system components and circuits were designed respectively in detail. The prototype was developed and experimental results verified the feasibility of the design strategy. The design will provide a new solution and implementation methods for the power supply of outdoor controller equipment.

Keywords Power supply system, Low-power, Photovoltaic, Outdoor controller equipment

INTRODUCTION

Solar photovoltaic energy as a renewable resource, has the advantage of clean environment, sustainable utilize, which has been widely applied and development**[**Li *et al.*, 2015**]** **[**Gao *et al.*, 2015**]**.Outdoor controller as one of the main forms of control equipment, access to a growing number of applications, especially in environmental monitoring, outdoor surveillance applications and others.

The conventional outdoor controller equipment applications are using ordinary power or battery power supply, which limits the range of applications and flexible application of the equipment to some extent.

As the technology matures of photovoltaic applications, the photovoltaic power supply is applied to the outdoor controller equipment, which will provide continuous power energy, they can solve the power supply problem of the outdoor controller equipment.

Therefore, a new low-power solar green power supply for outdoor controller equipment was designed in this paper.

SYSTEM COMPOSITION

The outdoor controller equipment utilize solar-powered, which can solve the unsustainable power supply and other problems of conventional power supply. The circuits system diagram of a new low-power solar green power supply shown in Fig.1.

After receiving sunlight the solar cells through a dedicated chip processed and achieve lithium battery charging management, lithium batteries store electrical energy collection. Then, after the processing circuit output DC voltage regulator. In order to meet different application requirements. The designed power supply can output different voltage depending on the different applications, such as DC5V or DC3.3V.

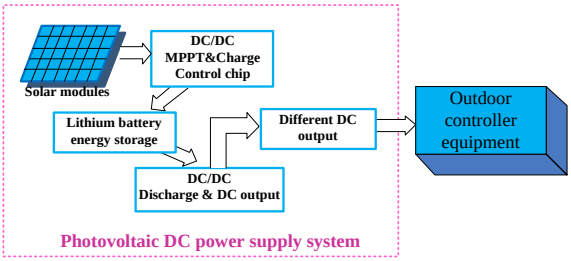

Figure 1.The new power supply system composition structure diagram

SOLAR CELL CHARACTERISTICS AND LITHIUM ION BATTERY

Solar photovoltaic cell characteristics[Dai *et al.*, 2015] [Tang *et al.*, 2014] [Zhou *et al.*, 2008] [Dong et *al.*, 2013]

The solar photovoltaic cells are semiconductor device that can absorb sunlight and convert it into electrical energy. According to the structure and the internal output voltage characteristics of photovoltaic cells, obtained equivalent circuit of solar photovoltaic cells shown in Fig.2.

According to the equivalent circuit diagram, the output current and power can be drawn as follows:

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$$i = I_{pv} - I_D(e^{\frac{qi(R_L+R_S)}{AKT}}) - \frac{i(R_L+R_S)}{R_{sh}} \quad (1)$$

$$P_o = u \bullet i \quad (2)$$

Wherein, I_{pv} is a light generated current by photovoltaic cells, which is proportional to the temperature of the light radiation, the battery, I_D is PN junction diffusion current.

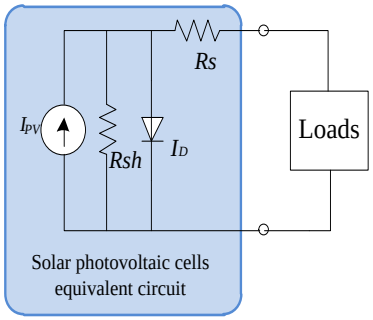

Figure 2. The equivalent circuit of solar photovoltaic cell

Output characteristic curves of the photovoltaic cell shown in Fig.3.

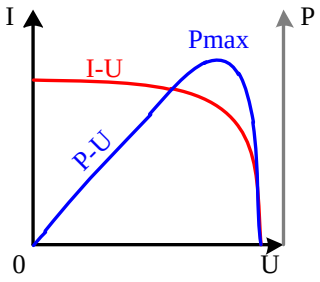

Figure 3. The output characteristic curves of the photovoltaic cell

Because photovoltaic output voltage and current with the sunshine intensity and battery junction temperature change has a strong nonlinearity. Therefore, there is a unique point of maximum power output (MPP) in a particular application environment. In practical applications, the radiation intensity of natural light and white light transmission rate of the dynamic changes in the atmosphere, in order to get much more energy in the same sunshine intensity and junction temperature, which has the existence of a maximum power point tracking output (MPPT) issues.

Lithium Ion Battery[Chen *et al.*, 2007] [Gao *et al.*, 2014]

Compared with other batteries, lithium ion batteries in many aspects predominate: they can provide a higher energy density and higher battery voltage, no memory effect, with longer charge retention time charge cycle, etc.

The ordinary lithiumion battery equivalent circuit shown in Fig.4.

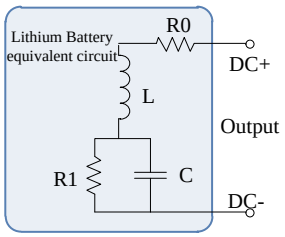

Figure 4. Lithium battery equivalent circuit

POWER SUPPLY CIRCUITS DESIGN

The control circuits design includes solar charging management and discharge control circuit sections. Taking into account the reliability and compactness of the entire power system, using a dedicated power supply control chip design. The control system composition diagram shown in Fig.5.

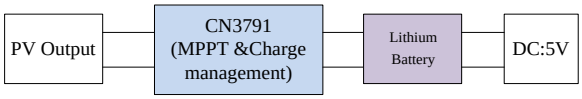

Figure 5. The composition diagram of control system

Wherein the charging circuit using a dedicated control chip CN3791 design[9]. The charging Circuit schematics shown in Fig.6.

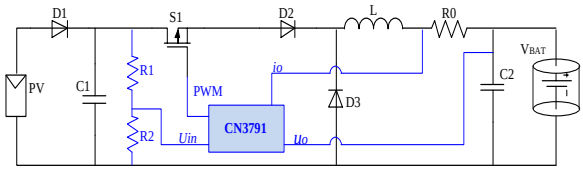

Figure 6.The charging circuit schematics

In order to improve power conversion efficiency, lithiumion battery discharge DC / DC converter used high efficiency synchronous rectification chip G5177 [10]achieve DC/DC output control, the converter diagram inFig.7.

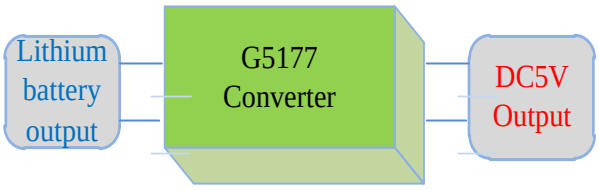

Figure 7.DC / DC converter based on G5177 chip

THE EXPERIMENTAL RESULTS

A prototype system for test experiment was developed. The test experimental system shown in Fig.8, the system including solar cells, the control circuits, storage batteries and application load, etc.,

the load is a outdoor intelligent controller, operating voltage of DC5V.

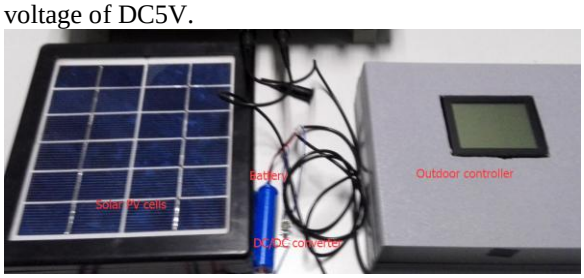

Figure 8. The prototype system test experiment

The experimental test waveforms shown in Fig.9. As can be seen from the test experimental waveforms and test experiments, used pure hardware circuits(dedicated circuit chips) design. It has the advantage of tracking reliability and output stable. The controller can ensure reliable and stable work.

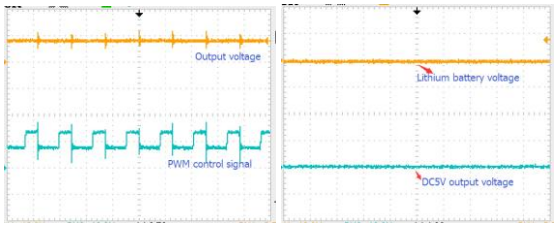

Figure 9. Test experimental waveforms

CONCLUSION

In this paper, aimed at the application requirements of outdoor controller equipment power supply. Designed and development of a new low-power power supply for outdoor controller equipment applications. The composition of power supply, the working principle and circuits were introduced. And a prototype was developed, the experimental verification results show accurate and reliable of the design strategy. The design provides a new solution and implementation methods for the power supply of outdoor controller equipment.

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REFERENCES

CHEN Xueyuan, TIAN Xiaoming, YU Tianguo, 2007,"Li-ion Battery Charging Method Based on Handheld Navigation Products",pp182-183

DAI Zhi-wei, SHU Jie,WU Chang-hong,2015, "Research on the Algorithm of Constant Voltgae MPPT Control Method Based on Environmental Parameter Model", Power Electronics, vo1.49 ,no5,pp61-63

DONG You-er, MENG Yu,SHEN Tian-tian, TANU Jin-e,2013,"Research and Applications of PV Systems",Journal of Shanxi Univcrsity(Nat. Sci. Ed.),vol36,no1,pp40-48

GAO Chun-fu, LU Shuang, HE Xin-sheng, WANG Bin,XIE Chu-xiong,2014,"Design of maximum power point tracking controller with photovoltaic power generation", vol.40 no.2,pp70-73

GAO Linchao, HAO Qingying,ZHU Yeyu,DING Minig，JIA Bing,2015, "Research and design on household standalone photovoltaic power generation system", Journal of Henan Agricultural University, vo1.49 no.1,pp83-87.

LI Huabo,2015, "Design of Photovoltaic Power Generation Supply of High Voltage Insulator Parameters Online Monitoring System", High Voltage Apparatus, vo1.51, no 6,pp68-73.

Tang Lei, Zeng Chengbi, Miao Hong, 2014,"THE PV MAXIMUM POWER POINT TRACKING ALGORITHM BASED ON FUZZY PI BIDIRECTIONAL LINEAR PREDICTION METHODOLOGY" vol35, no11,2014,pp2077-2081

ZHOU Lin, WU Jian, LI Qiu-hua, GUO Ke,2008, "Survey of Maximum Power Point Tracking Techniques for Photovoltaic Array", High Voltage Enerineering, vol34,no6,pp1145-1152

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