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Implementation of LED Lighting Powered by Solar Energy for Bicycles

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ABSTRACT

The high efficiency, simple driving, environmental protection and long life of high power white-light diodes have attracted a lot of attention from industry and academia. High-efficiency white LEDs have the potential to replace traditional lighting such as incandescent bulbs and fluorescent lamps, and can be used in residential environments, industry and commercial advertising. Because of the advantages of light-emitting diodes, such as power saving, environmental protection, long life and fast response time, they will replace traditional light-emitting elements as the new lighting source in the future. Under the restrictions and regulations of the Kyoto Protocol, we will cooperate with the country to actively promote energy-saving technology and energy industry in the future. This paper proposes the development of LED lighting and photovoltaic, and the application of solar photovoltaic systems to bicycles, in line with the green technology industry LED lighting and solar photovoltaic industry development. Energy-saving LEDs can be combined with stand-alone lighting systems to enable the sustainable development of renewable energy development and energy conservation policies in Taiwan.

Keywords: Solar cells, Light-emitting diodes, LED lamp drivers, White LEDs

1. INTRODUCTION

In recent years, the world has promoted the concept of energy saving and carbon reduction as well as the rise of environmental awareness, making the future of electronic products must also take into account the function of energy saving. The incandescent bulb has sufficient illumination and good color rendering, but the power consumption is as much as 40W~60W with high heat generation, low efficiency, short life and other disadvantages [1-2]. Although fluorescent lamps are more energy-efficient than incandescent bulbs, have lower heat output and longer life span, the spectrum of fluorescent lamps is intermittent, and the color rendering is poor, and the pale light is not pleasing. Especially its strobe effect, easy to make people eye fatigue, in addition to the lamp contains toxic mercury vapor, does not meet the current concept of environmental protection. In order to improve the above-mentioned shortcomings, the industry has invested in LED to replace the traditional lighting research. LED has the advantages of small size, long life, good color saturation, power saving, low voltage operation and no mercury.

White LEDs have many advantages over traditional white woven bulbs and fluorescent lamps, such as small size, low heat generation, low power consumption, long life, fast response time, flat package, and easy development into thin, light, and short products. There are no drawbacks such as high power consumption of incandescent bulbs, fragility and mercury contamination of fluorescent lamp waste. So there are green lighting light source of white LED, become in Europe, the United States, Japan and other advanced countries into the research and development work. As the luminous efficiency of white LEDs has gradually increased in recent years, white LEDs have become a promising and eye-catching product in the LED industry [2]. The following is a comparison of the characteristics of commonly used lighting sources, as shown in Table 1 [3-4].

Table 1. Comparison of the characteristics of commonly used lighting sources in general [4]

	Luminous efficiency (lm/W)	Color temperature (K)	Color rendering	Life span (hr)
Incandescent bulb	8~17	2100~3300	100	>1000
Halogen Tungsten Lamp	18~20	2100~3300	100	1500~2500
Fluorescent lamp	25~100	2100~3300	40~90	10000~20000
CCFL	30~95	~6500	~72	20000~50000
HID	65~100	3000~5000	60~80	5000~20000
White LED	>65~100	5000~7000	>70~75	~100000

Since bicycles on the market are not equipped with lighting, it is a bit dangerous to ride at night. In order to solve the problem of driving safety, we want to design headlights on bicycles. At present, there are bicycle headlights on the market, but those are to install the battery, I want to say that if the battery into a rechargeable battery, and then add the solar panel. The use of photovoltaic energy, which can take into account both environmental protection and energy saving, and will not create a bunch of waste batteries out, so we want to combine the two to form a photovoltaic-energy LED bicycle lighting.

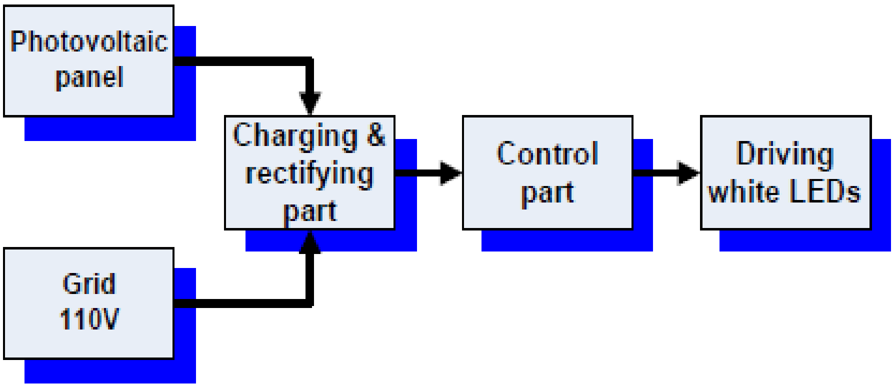

Figure 1: The Block schematic

The main structure is divided into four parts: power supply, charging rectifier, control and LED driver. The principle of simple structure action is shown in Figure 2: first use the solar panel as shown in Figure 3. The power is generated, rectified and charged to the rechargeable battery, which then provides power to the LM3914 to drive the LEDs and turn them on. As for the power supply, in addition to the solar panel charging, you can also use the grid 110V through the transformer to charge the battery. So there are 2 options for the power supply. In addition, a switch is installed between the power supply and the LED to control whether the LED emits light or not.

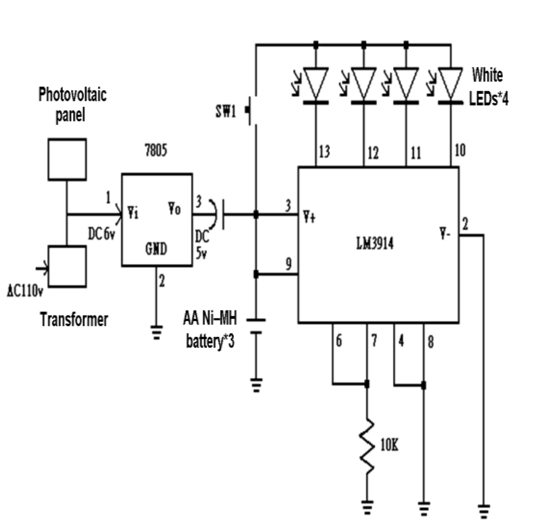

Figure 2: The circuit diagram

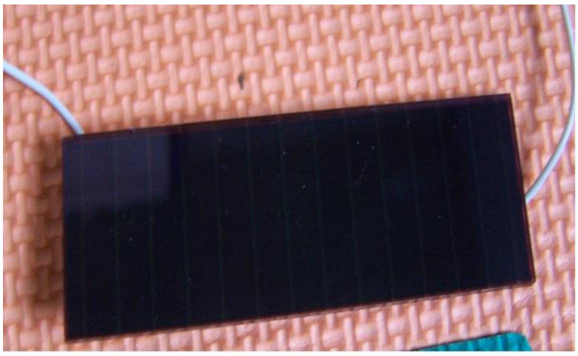

Figure 3: The photovoltaic panel

2. PHOTOVOLTAIC CONVERSION PRINCIPLE OF SOLAR CELLS

The main function of solar cells is to convert light energy into electrical energy, a phenomenon known as the photo voltaic effect [5-6]. The photovoltaic effect was discovered in the 19th century and was used to make selenium photovoltaic cells in the early days. It was only after the invention of transistors that the semiconductor properties and related technologies gradually matured, making the manufacture of solar cells possible. The reason why solar cells can convert light energy into electricity is mainly due to two factors: one is the photo conductive effect, and the other is the internal electric field. Therefore, when selecting materials for solar cells, it is important to consider the photo-conductivity of the material and how the internal electric field is generated.

When light shines on a material, part of the light will be absorbed by the material and part of the light will leave the material through reflection or penetration. The first consideration in selecting a solar cell material is that the light absorption effect should be good so that the output power can be increased. The second consideration in selecting solar cell materials is the photo-conductive effect. In order to select materials with good photo-conductive effect, we must first understand the composition of sunlight and its energy distribution, and then find the appropriate material for solar cell materials. Figure 4 shows the distribution of energy when the sunlight passes through different atmospheric thicknesses. AM is the unit for calculating atmospheric thickness, and AM0 is the original condition of the sunlight before it enters the atmosphere. The diagram shows that some components of the sunlight will be filtered out by the atmosphere after it enters the atmosphere, so there will be different considerations for solar cells used in space or on the surface. According to the distribution of solar energy, the material with the best photoconductivity is silicon or Ga-As semiconductor material. Silicon is the main raw material for practical solar cells because of its abundant content and mature technology [7]-[9].

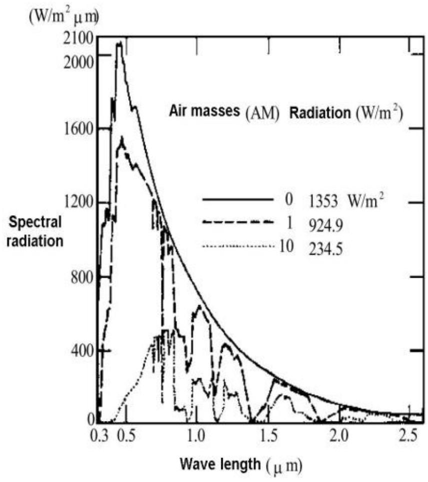

Figure 4: Solar energy distribution diagram

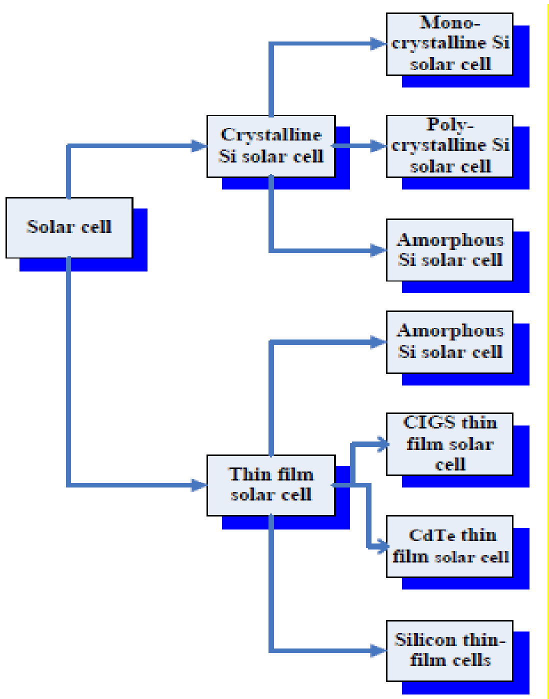

Figure 5: Types of solar cells [11]

Commonly used solar cells can be divided into three types depending on the crystalline structure of silicon: monocrystalline solar cells, polycrystalline solar cells, and amorphous silicon solar cells. Monocrystalline silicon solar cells and polycrystalline silicon solar cells can be collectively referred to as crystalline silicon solar cells. The photovoltaic conversion principle of these three types of solar cells is more or less the same as the conversion principle introduced earlier, but the structure differs due to different considerations, and thus different solar cells are developed. Among them, monocrystalline solar cells have the best photovoltaic efficiency but the highest cost, while amorphous silicon solar cells have the worst efficiency but the lowest cost. Efficiency and cost are the most basic considerations for solar cells, but there are many factors that must be taken into account in practical applications besides efficiency and cost, such as the deterioration of efficiency over time. To design a good solar energy system, it is very important to understand the advantages and disadvantages of various solar cells. Various types of solar cells are shown in Figure 5 [10].

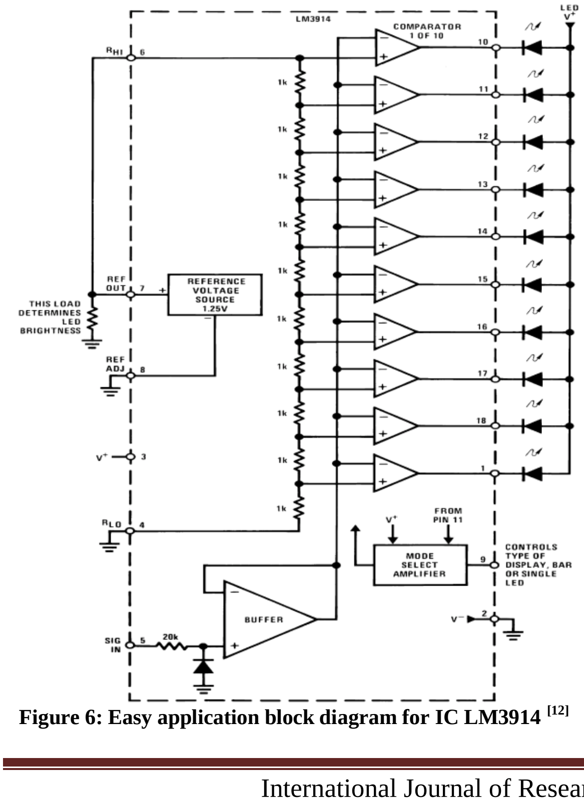

Figure 6: Easy application block diagram for IC LM3914 [12]

3. IC LM3914 LED DRIVER

The LM3914 is a 10-bit light-emitting diode (LED) driver, as shown in the dashed internal block diagram in Figure 6. It can convert the input analog quantity to bit output to drive a 10-bit LED for dot display or bar display. Features: 1. Users can drive LED, LCD, or fluorescent lamp. 2. Users can choose column or dot display from external. 3. Internal voltage reference values can be from 1.2V to 12V. 4. Input voltage can be tolerated up to ±35V without affecting the output. 6. Output can be connected to TTL or CMOS logic gate [11]. The current-temperature diagram is shown in Figure 7.

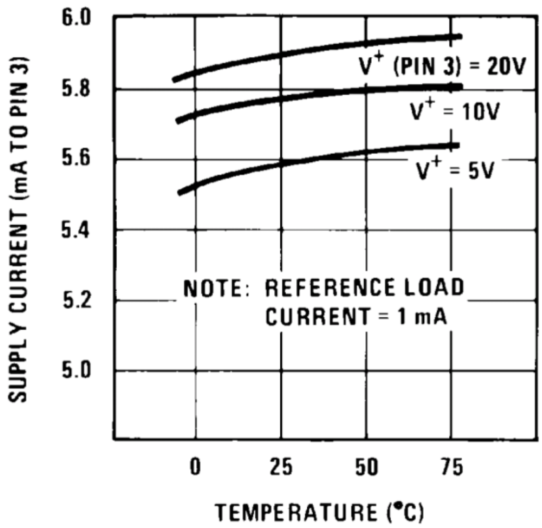

Figure 7: Current-temperature diagram of IC LM3914 [12]

Table 2 Battery voltage measurements at both ends

Time	Voltage	Description
2020/01/11 09：00	3.82v	Voltage measured before the LED is switched on
2020/01/11 10：30	3.79v	Measured voltage after 1 hour and 30 minutes of LED on
2020/01/11 12：00	3.81v	Measured voltage after 1 hour and 30 minutes of LED switch-off (charged by solar panel)

4. PRODUCTION RESULTS

Specifications of the rechargeable battery used in this circuit: Ni-Mh Rechargeable Battery.

Type: AA (No. 3 battery)

Brand: SONY

Specifications: 1.2v; 1700mAh

The voltage measurements at the two end points of the battery are shown in Table 2.

Table 2 is the record of "Battery voltage measurement at both ends", which shows the recovery of the battery voltage after using the LEDs and leaving the board idle for a period of time indoors. It indicates that the solar panel is functioning properly to charge the batteries, and that the maximum battery voltage is 3.82V (using three AA batteries). Figure 8 shows the finished unit and Figure 9 shows the finished product.

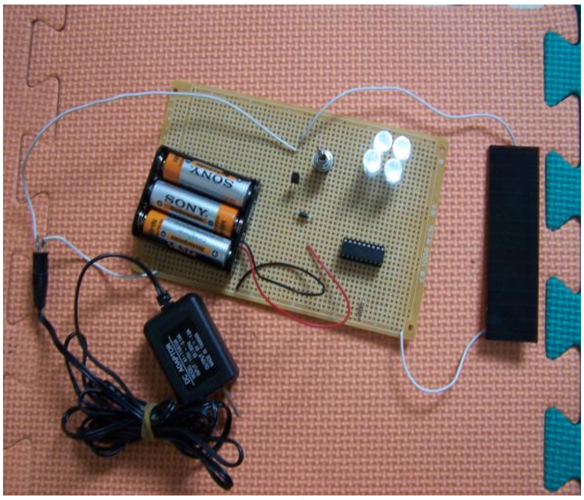

Figure 8: The finished unit


Figure 9: The finished product

There is still room for improvement in this circuit, including the remaining battery capacity, charging itself when the battery is low, and automatically discharging the battery when it is fully charged, so that it can be truly effective.

5. CONCLUSION

White LED, basically does not have the disadvantages of incandescent bulbs, fluorescent lamps, but the price is too high, color rendering can not be improved, is its main disadvantage. However, the rapid semiconductor lighting still needs some time, the competition for alternative products is easier to start, LED characteristics and traditional lighting needs of the difference (Gap) need to work [2]. If coupled with energy-saving measures, we will have sustainable energy available.

6. ACKNOWLEDGMENTS

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REFERENCES

1. Y.J. Chuang, and J.J. Hu, "Flyback Converter For Light Emitting Diode Driver Circuit," 2009 The 8 th Taiwan Power Electronics Conference & Exhibition Program, Vol.1, pp.888-893, 2009.
2. B.R. Lin, Y.C. Chiang, and F.P. Tsao, "Design and implementation of power converters for LED desk lamp with dimmer," 2009 The 8th Taiwan Power Electronics Conference & Exhibition Program, Vol.1, pp.1306-1311, 2009.
3. Y.N. Hu, and H.M. Chen, "The Research and Design of Improving Luminous Decay of Di-Chromatic White LED," 2009 The 8th Taiwan Power Electronics Conference & Exhibition Program, Vol.1, pp.1332-1336, 2009.
4. Technology overview of white LEDs, http://www.laser.net.cn/Show.asp?classid=3&id=200.
5. G.X. Luo, Solar Cell Technology - Current Status and Prospects, Energy Committee, Ministry of Economic Affairs, February, 1987.

6. C.C. Chuang, Solar Energy Engineering - Solar Cell Chapter, Chuan Hwa Book Co., LTD., 1997.
7. S. M. SZE, Semiconductor Devices Physics and Technology, Bell Telephone Laboratories, Inc., 1985.
8. M. Shur, Physics of Semiconductor Devices, Prentice-Hall,Inc., 1990.
9. D. A. Neamen, Semiconductor Physics and Devices, Richard D. Irwin, Inc., 1992.
10. C.L. Huang, Research and Development of Parallel Converter for Solar cell and Grid, Master's Thesis, Institute of Electrical Engineering, National Yunlin University of Science and Technology, Taiwan, 2007.
11. National Semiconductor Corporation, http://www.national.com/

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