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DESIGN AND CONSTRUCTION OF SOLAR PANEL CHARGING CONTROLLER

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Abstract

The solar panel charging controlled system is designed and constructed using the microcontroller and light sensor. The design of solar panel charging controlled system consists of a mid-range PIC microcontroller (PIC16F877A), an alphanumeric liquid crystal display, a crystal oscillator and a 5V relay. The controller circuit was operated by a 5V dc power supply. Microcontroller checks the specified minimum and maximum voltage or less than voltage of battery. If the battery voltage is lower than the predetermined minimum or maximum voltage, battery is charged. If the battery voltage is greater than the maximum voltage, the charging circuit is cut off via relay. This can be saved the battery life span and prevent from the setting fire.

Materials and Method

Materials

In this research, PIC microcontroller, solar cell panel, LCD display, relay and push buttons are used as hardware and Basic Pro language is used as software. The PIC16F877A is a high performance reduced instruction set computer CPU. It is necessary to learn 35 single word instructions to use the device. The device can be operated with 20MHz clock input and it contains 8K x 14 words of FLASH Program Memory, 368 x 8 bytes of Data Memory and 256 x 8 bytes of EEPROM Data Memory. The PIC16F877A comes in 40 pin packages as shown in Figure 1. There are 5 I/OPORTS, PORTA, PORTB, PORTC, PORTD and PORTE. Moreover, the device consists of 14 interrupts and both serial and parallel communication features. The serial communication uses MSSP (Master Slave Serial Programming) and USART (Universal Synchronous Asynchronous Receiver Transmitter). The parallel communication uses PSP (Parallel Slave Port).

Photovoltaic solar panels absorb sunlightas a source of energy to generate electricity. A photovoltaic (PV) module is a packaged; connect assembly of typically 6x10 photovoltaic solar cells. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 365 Watts (W). The efficiency of a module determines the area of a module given the same rated output an 8% efficient 230 W module will have twice the area of a 16% efficient 230 W module. There are a few commercially available solar modules that exceed efficiency of 22% and reportedly also exceeding 24%.

The HD44780 dot-matrix liquid crystal displays alphanumeric, Japanese katakana characters, and symbols. It can be configured to drive a dot-matrix liquid crystal display under the control of a 4- or 8-bit microprocessor. Since all the functions such as display RAM, character generator, and liquid crystal driver, required for driving a dot-matrix liquid crystal display are internally provided on one chip, a minimal system can be interfaced with this

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controller/driver. The HD44780 character generator ROM is extended to generate 208 5 × 8 dot character fonts and 32 5 × 10 dot character fonts for a total of 240 different character fonts. The low power supply (2.7V to 5.5V) of the HD44780 is suitable for any portable battery-driven product requiring low power dissipation.

Method

The schematic diagram of solar panel charging control system is shown in Figure 1. The circuit design consists of PIC16F877A, a 4MHz crystal oscillator, voltage divider circuits, three control input switches, a reset switch, a 5V relay and an alphanumeric liquid crystal display.

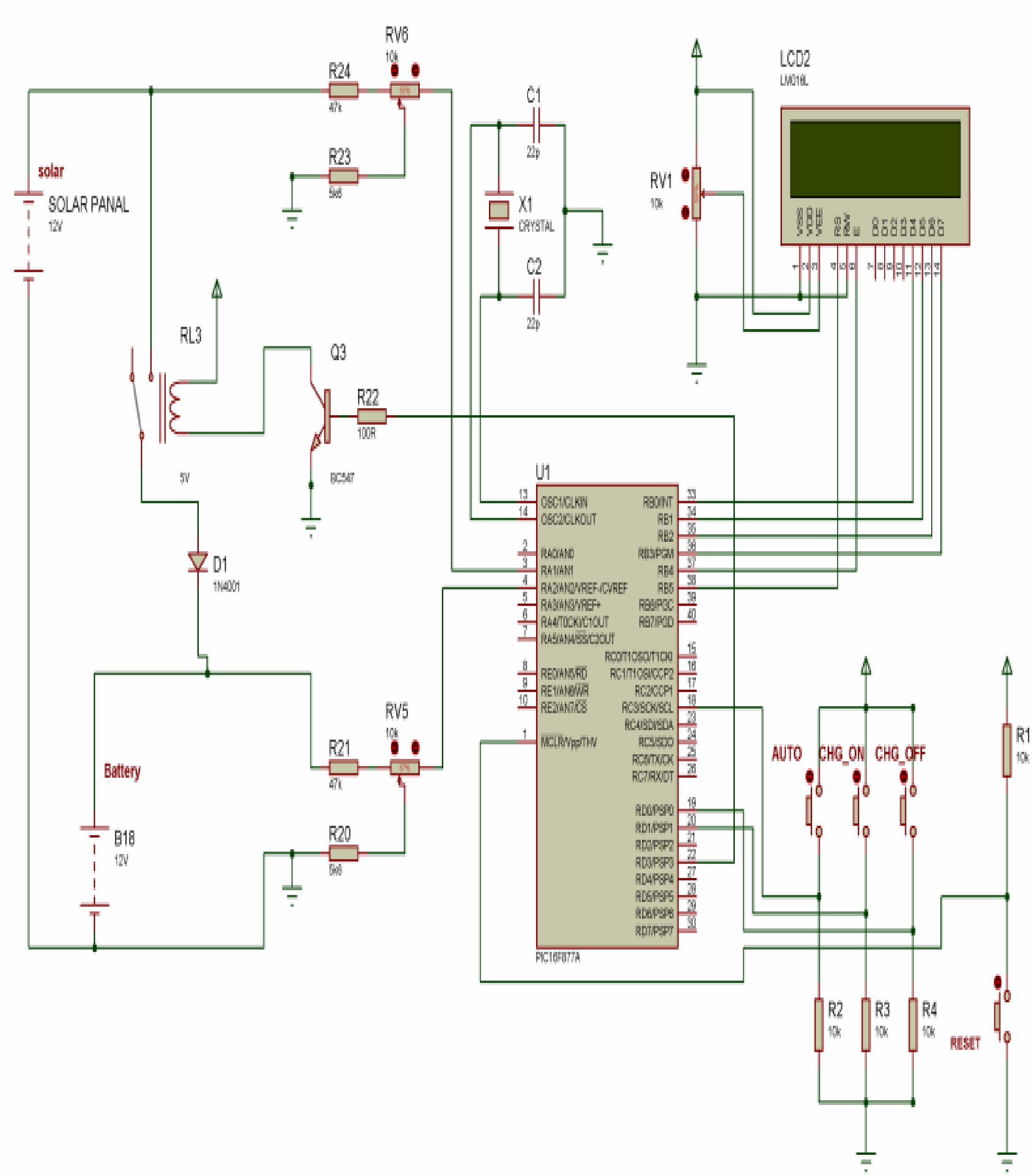

Figure 1 Schematic circuit diagram of Solar panel charging controlled system

The initial step to create the program sketch is drawing an outline flow diagram and it is usually known as flowchart diagram. The flowchart illustrate, programming flow with blocks and labels. In regular statements, it is illustrated with rectangular shape text boxes. In decision making process, it is illustrated with diamond shape text boxes. The flowchart is illustrated in Figure 2.

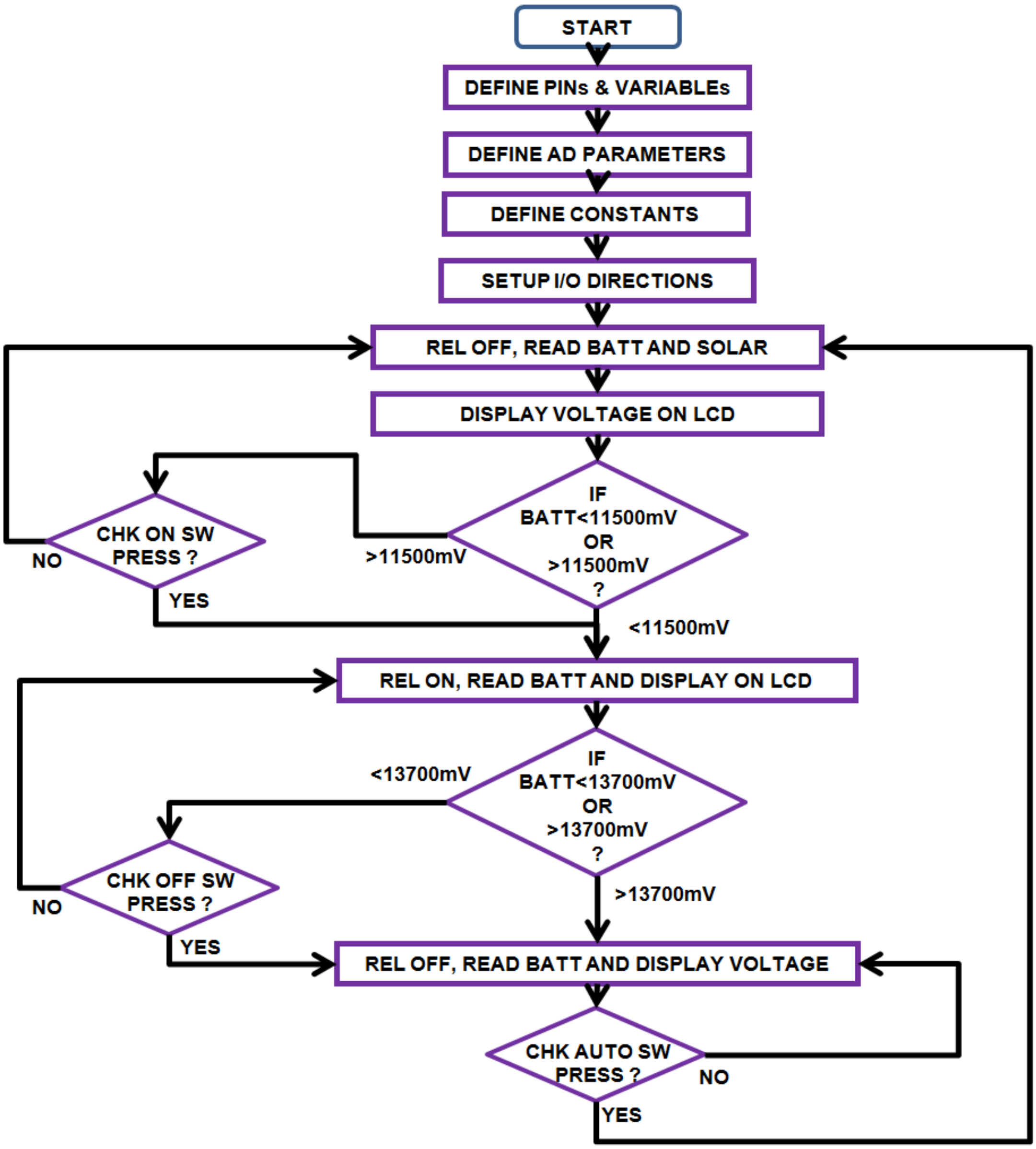

Figure 2 Flowchart

At the beginning of the program, I/O pins and variables are defined with suitable names. Then, analog to digital conversion parameters are defined to read battery and solar voltages. In this stage, the ADC resolution was taken for maximum 10 bit resolution. Therefore, minimum voltage the microcontroller can measure was 4.88mV. ADC conversion clock is operated with internal RC clock and data sampling time is about 50µs. Then, the input and output pin directions are setup for their operations. The program looping started by initially switch off the relay for original condition. Then, the battery and solar voltages are read and display on the LCD as mV.

Then, the conditional testing for battery voltage was checked whether it is above or below the 11500mV (11.5V, recharge level). If the battery voltage is above 11500mV, the program checks for charging on switch. If the switch is not pressed, the program loops back to initial state.

If the battery voltage is lower than 11500mV or charging on switch is pressed, the program jump to charging on routine. In this routine relay is switched on and read the battery voltage and display on LCD. Then, the program check the battery voltage condition, whether it is greater than maximum charging level (13700mV or 13.7V). If it is less than 13700mV, the program jumps to check the charging off switch. If the switch is not pressed, the program loops back to charging on routine.

If the battery voltage is greater than maximum voltage level or charging off switch is pressed, the relay is switched off to disconnect the solar panel and battery. Then, the program again checks for auto function switch. If it is not pressed, the system cannot initiate automatic charging function. If it is pressed, the program loops back to initial routine.

Operation of solar cell panel charging controlled system

The circuit of solar cell panel charging controlled system is constructed and connected to solar cell panel as shown in Figure 3.Before connecting the battery and solar panel, their voltages are checked with a digital voltmeter. The solar panel used in the circuit is TATA BP SOLAR and the voltage rating is 12V-5Watt solar panel. The voltage of solar panel in the room is about 5.5V, but in the bright sun light, it is about 14.5V.Therefore, the solar panel is required to locate under the bright sunlight for charging the battery. Then, measure the battery voltage. The battery is Leopard sealed lead acid 12V 4Ahr battery. The voltmeter indicates the new battery is about 12.7V and it is ready to use. Then, the battery and solar cell panel are installed on the control circuit terminals.

Then, the power supply is switched on for the control circuit. The LCD display cannot illuminate the characters clearly on the display; therefore, the yellow variable resistor on the left side of the LCD display is adjusted to achieve clear fine contrast characters on the display. Then, the reset switch is pressed again the LCD display initiated with the research title as shown in Figure 4.

Then, the battery and solar panel voltages are read with analog input of microcontroller and display on the LCD. The charging off condition is display on the right side of the LCD as shown in Figure 5. Since the battery voltage is 12930mV and solar voltage is 14490mV so that the battery voltage is above the charging level and charging condition is in the off state. It will not be automatically charge unless the battery voltage is below the minimum battery level. The minimum battery level is setup for about 11500mV in this control system. But the user can manually charge by pressing the charging on switch. There is a click sound from the relay when the switch is pressed and display illuminated as shown the Figure 6 for charging on state. While it is charging, the battery level gradually increases and after a few hours, the battery voltage becomes greater than the maximum voltage level (13700 mV). Then, the relay is automatically switched off the charging and back to initial state. Another method to stop the charging before the battery level become maximum voltage level is charging off switch. Pressing the charging stop button switched off the charging condition and display for battery and solar voltages, but did not loop back to automatic initial state. Therefore, to be back to automatic charging condition, the automatic function input switch is required to press, if conditional charging stop was made by using charging off switch. In this way, the battery can be automatically repeatedly charge within safe battery charging level and the battery is ever ready to use.

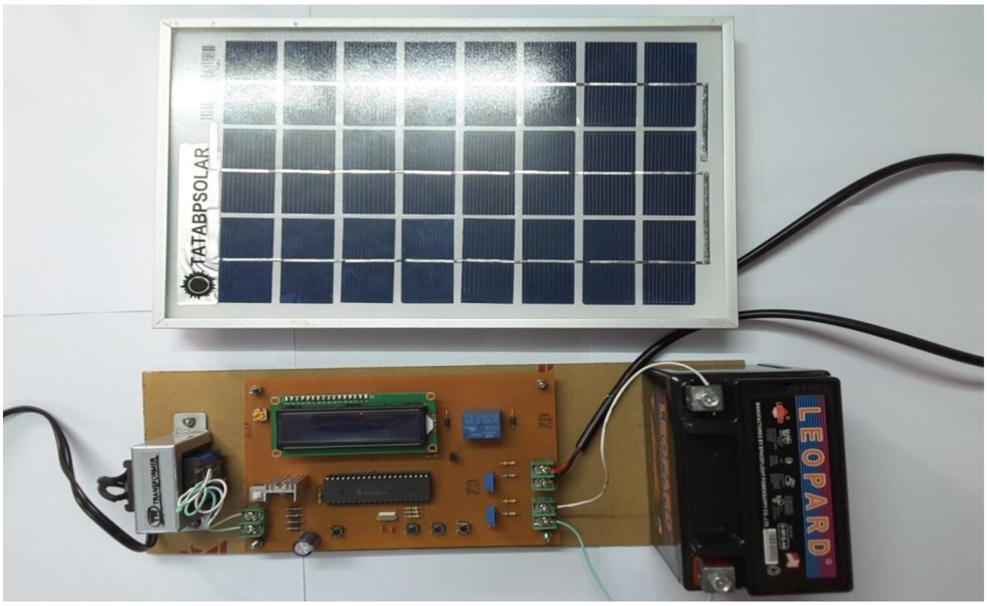

Figure 3 Complete connection of solar charging control system

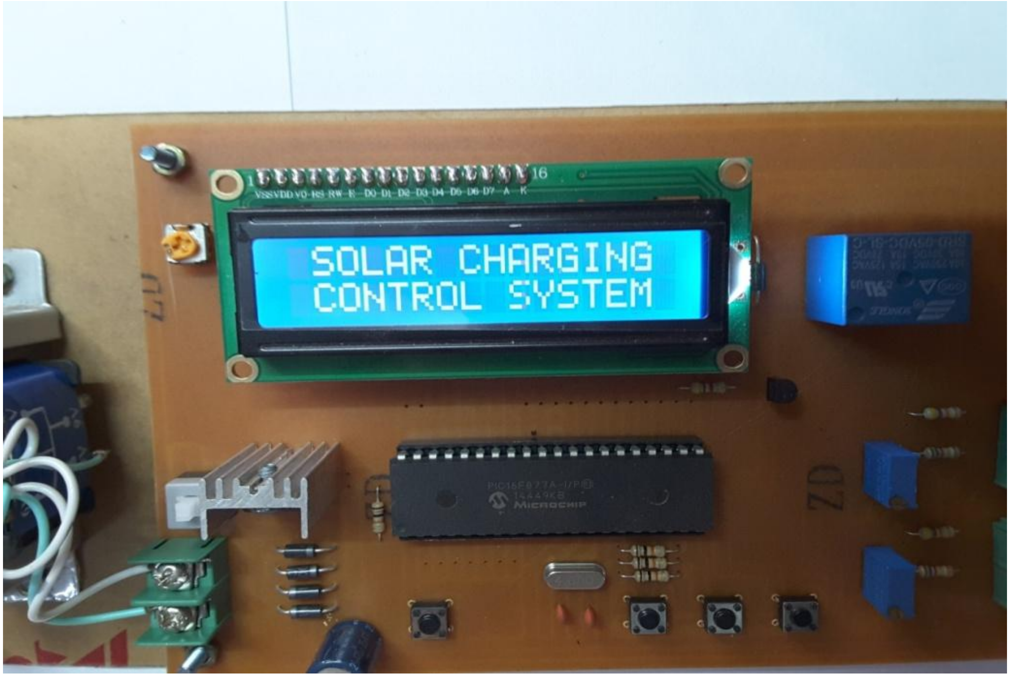

Figure 4 Initiating the program

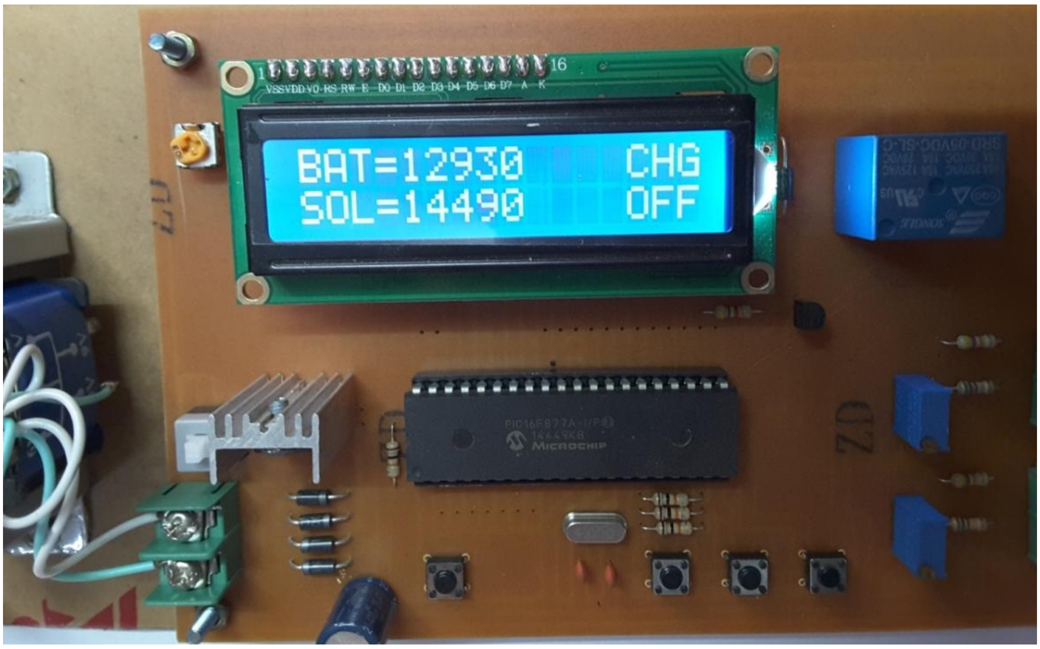

Figure 5 Charging off

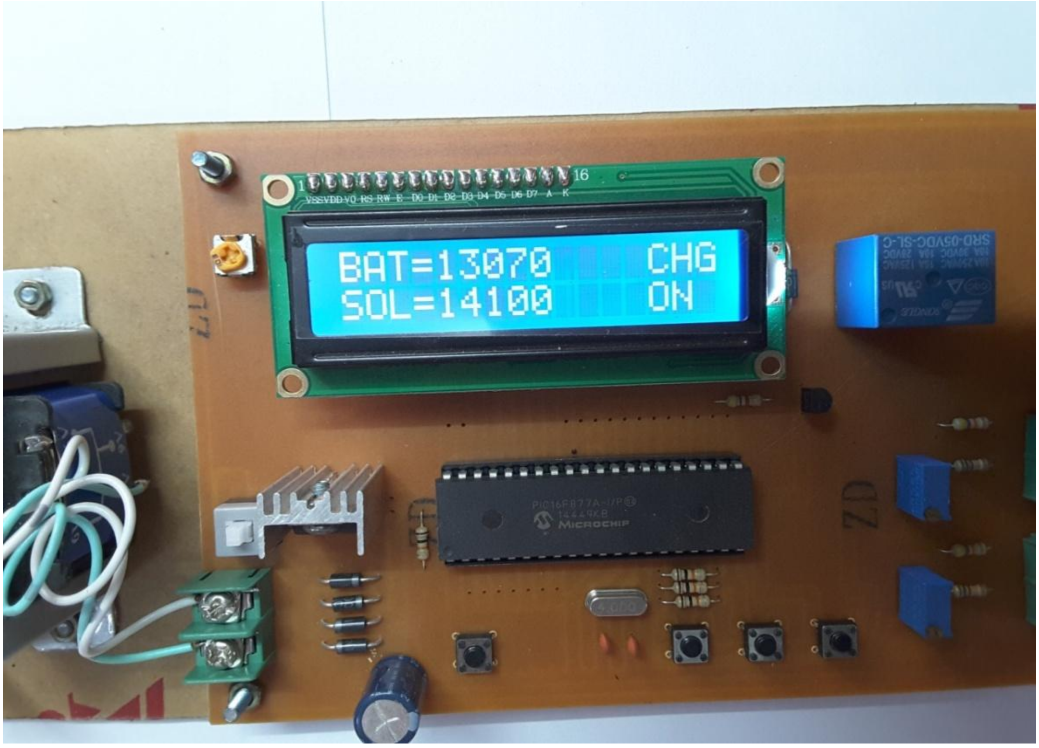

Figure 6 Charging on

Discussion

The solar charging controller is successfully constructed by PIC Microcontroller 16F877A. The four major portions consist in this circuit. There are PIC16F877A Microcontroller, inputs, outputs and display. The power supply unit is adding in this circuit for display of adjust input and output voltage to battery. This circuit is adjusted by manual and automatic operation. This circuit is control between solar panel and battery.

Conclusion

The solar panel charging control system is constructed and tested. As soon as the power switch is on, the battery level immediately display on the LCD in mV. The testing of the circuit results are illustrated with the photos. When the battery level falls to low level, charging started automatically. The manual input switch is supported to manual charging, before battery level falls to low level. When the charging complete, the charging automatically stop to prevent overcharging battery. The battery can be applied for any other 12 V devices for lighting, dc fan operating and so on. Normally, the charging period lasted for about 4 hours under test running for 4000 mAhr battery. But the charging time may vary according to the sunlight intensity. Discharging the battery by using a 3W LED lamp lasted for about 16 hours. It is reliable and able to use full life time of a battery.

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