# Wind Charge Controller for Golf Car using Peripheral Interface Controller (PIC)

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*Abstract* - **This paper presents wind charge controller for golf car using Peripheral Interface Controller (PIC). The purpose of this work is to describe the implementation of a controller for tracking the point of maximum power transfer based on neural networks, using a microcontroller of the PIC family, on energy system that used wind turbines. The general principal behind the controller is to monitor the voltage of the batteries in this system that either sends power from the turbine into the batteries to recharge them, or dumps the power from the turbine into a secondary load if the batteries fully charged. PIC controller system used to prevent over-charging and destroying the batteries. The program was built by using MPLAB software and PICkit 2 programmer. The wind charge controller will begins charging at 6 Volt and it will be fully charged at 9 Volt.**

***Keywords: Peripheral Interface Controller (PIC), charge controller, wind turbine, over-charging, MPLAB software, PICkit 2***

## I. INTRODUCTION

Wind is one of the renewable energy sources. Wind energy it is clean and the availability of useless character [1]. Today wind energy is used for power generation had been rapidly and widely. By the end of 2007, the overall worldwide wind power installation capacity had surpassed 94GW [2]. In Malaysia the windy weather throughout the year made it easy to generate wind power. In this project the wind power that is produced from wind turbine was used for charging the battery golf car.

The most important part of this project is that charge controller. The primary function of a charge controller is to protect the battery from overcharged or damage. The basic parameter and characteristics for charge controller depends on the operating temperatures, load current losses, the magnitude of the battery current and load voltages [3].The general principal behind the controller is that it monitors the voltage of the battery in system and either sends power from the turbine into the batteries to recharge them, or dumps the power from the turbine into a secondary load if the batteries was fully charged [4].

A program used for this based on PIC microcontroller. PIC microcontroller was better than another integrated circuit. Microcontroller differs from another integrated circuit in many ways. The PIC 16F877a is also a good choice for learning about micro-controllers, because the programming language is relatively simple, as compared with a microprocessor such as the Intel Pentium™ , which is used in the PC.The most important was its function, it was designed to be an all in on, there were no external parts were required for applications for all the peripherals required to have completed it [5].

The objective of this work was to design a charge controller. The second objective is monitor the charging and discharging of battery golf car automatically based on power coming from wind turbine. The system of charge controller was program used a PIC 16F877A one of the microcontroller family [6][7].

## II. THEORITICAL BACKGROUND

### A. *Description of the system*

Figure 1 presents a block diagram of the proposed energy system. This system was compiling of four basic elements:

- Wind turbine
- Charge controller
- Battery golf cart
- Dummy load

The wind turbine is generating dc power for supplying to the battery. The maximum voltage for this system is 12 volts. The charge controller consists of PIC integrated circuit to run overall system. That controller can support maximum 5 volts from wind power. The battery used has a 12 volts and the type is lead acid battery. The dummy load functions as secondary load. After battery is fully charged the voltage from generator moved into dummy load.

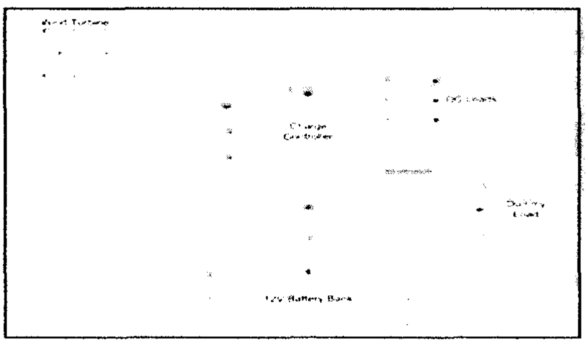

Figure 1. Block diagram of power system

### B. *Comparison between charge and full charged*

The Figure 2 shows comparison between start charging and full charging for 12 Volts batteries. Output voltage from generator was compared with output at voltage generator. The maximum output must produce approximately 5 volts to support

PIC circuit. The minimum comparison voltages for start charging are 2 Volt and maximum comparison voltages for full-charge are 5 volts. During battery start charging red LED will light up and at full charging green LED will turn on and relay will switch off to stop battery from charging. Relay will then provide voltage towards the cooling fan once the battery is fully charged.

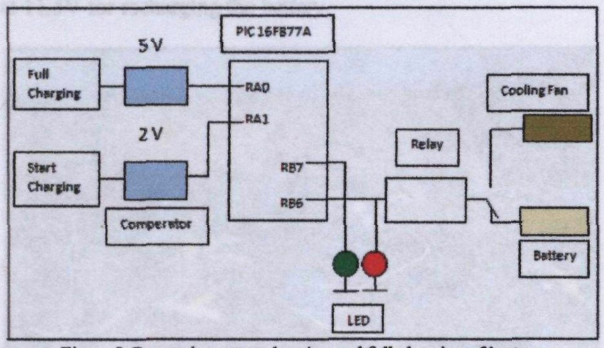

Figure 2.Comparison start charging and full charging of battery

### C. *Lead Acid battery energy storage technologies*

With the maturity of its technology preceding other batteries, Lead-Acid batteries had been used for over a century. They provide a cost-competitive and proven solution for several photovoltaic and micro-wind applications. High discharged rates can be achieved by using deep-cycle batteries. Low energy density, non-environment friendly electrolyte and a relatively limited life-cycle were the limiting factors to its dominant used in urban renewable energy systems [8]. Overall, with low maintenance requirements, relatively low self discharge rates, Lead-Acid batteries offer a competitive solution for energy storage applications [9].

## III. METHODOLOGY

### A. *Project Planning*

In the first action to develop this system, some of researches had been done. The first step identified the problem that occurred in this case. From the analysis, the significance of this project, source of information and then methodology was obtained. This methodology was divided into two stages. In the first stage, the research was focused on electrical and electronic part that contributes to the circuit design. The second stage, focus on software part to write the programming used MPLAB software. In Figure 3 below shows the whole stages of the project.

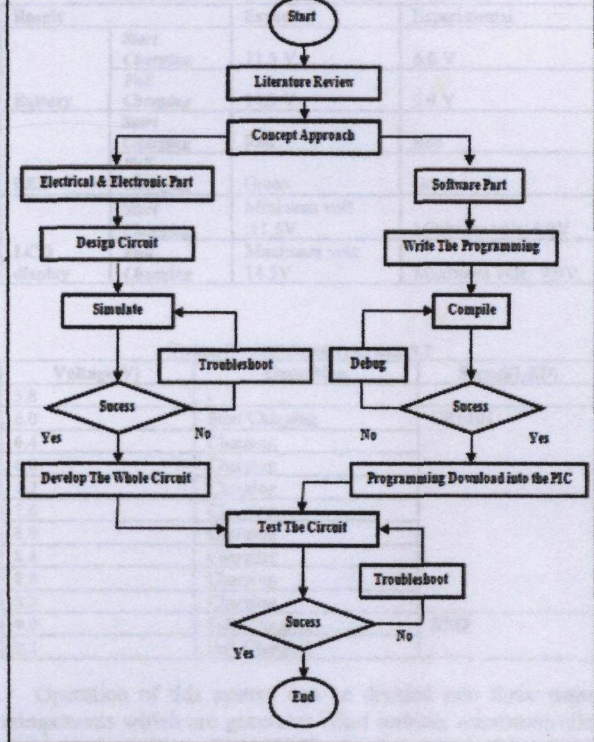

Figure 3. Project development flow chart

### B. *Project Block*

The Figure 4 shows the block projects that cover the overall project operation. There had three main elements in figure below like motor, charge controller and MPLAB. The motor used to give supply into charge controller. The charge controller used to reduce voltage supply from generator motor about 5 volt for used in PIC 16F877A. MPLAB element was programmed to give the LCD a specific command in order to display voltage battery charging and discharging on 2x16 LCD display.

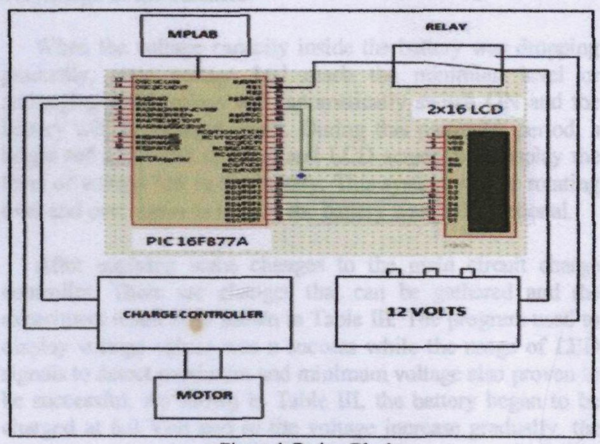

Figure 4. Project Block

## C. *Project Design*

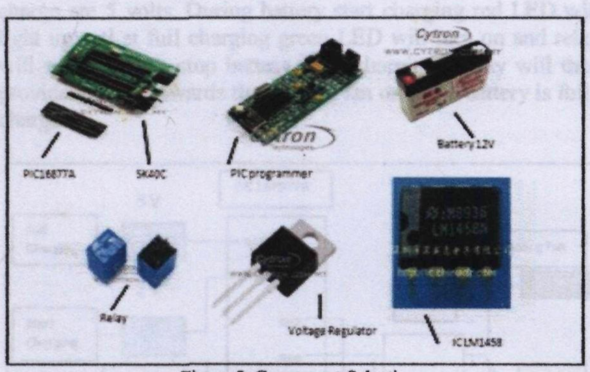


Figure 5. Component Selection

TABLE I. LIST COMPONENT USED

| No | Component | Quantity |
|---|---|---|
| 1 | SK40C | 1 |
| 2 | USBPIC Programmer | 1 |
| 3 | PIC 16F877A | 1 |
| 4 | IC LM1458 | 1 |
| 5 | Fuse | 2 |
| 6 | Capacitor | 2 |
| 7 | Switch | 2 |
| 8 | Diode | 2 |
| 9 | LED | 2 |
| 10 | Battery 12V | 1 |
| 11 | Resistor | 7 |
| 12 | Relay 12V | 1 |
| 13 | Voltage Regulator 5V | 1 |
| 14 | Single Turn Preset | 2 |
| 15 | Transistor IRF540 | 1 |

## D. *Programming Development*

MPLAB IDE software and PIC programmer had been used to write the program on the PIC16F877A [10]. The flow chart of this program can be seen in Figure 6.

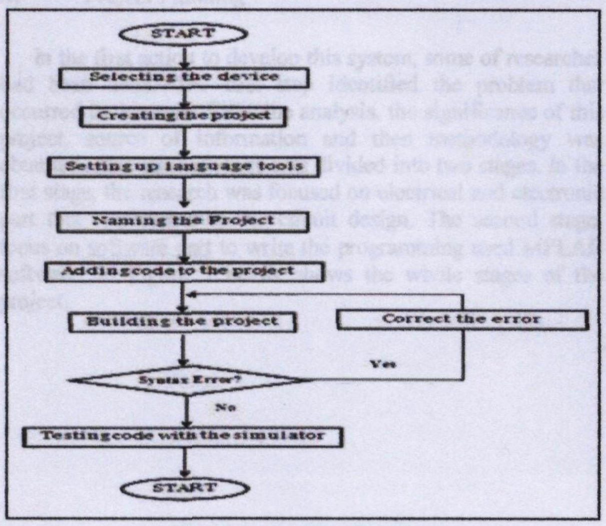


Figure 6. Programming flow chart

## E. *Programming for PIC16F877A*

Result for programming was done by using MPLAB IDE software. After completed writing an assembly language for the system, the programming written was simulated using 'build all' instruction to see if an error occurred [10]. When the source file was assembled, the output window will show the result of the build process as Figure 7 and ready to download to PIC shown in Figure 8. Then, the program will download into PIC16F877A as Figure 9.

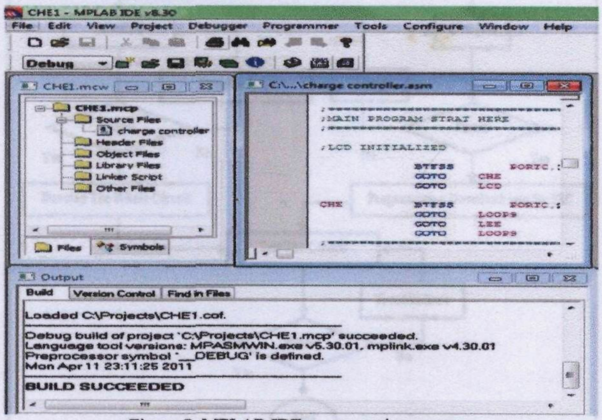


Figure 7. MPLAB IDE programming success

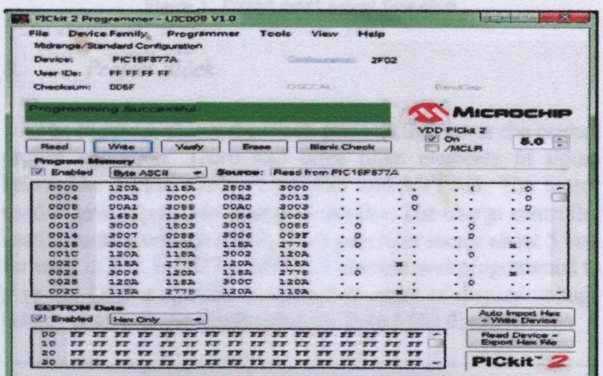


Figure 8. Ready to download into PIC16F877A

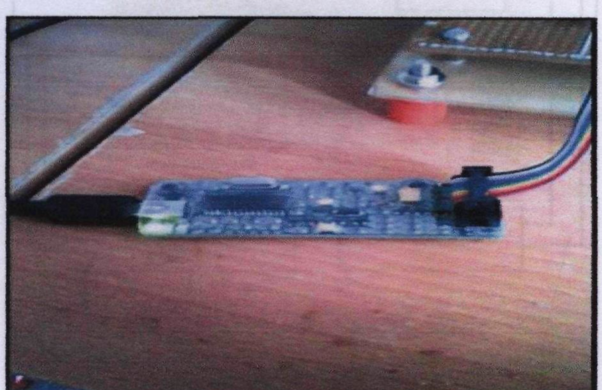

Figure 9. Download programming into PIC16F877A

## IV. RESULTS AND DISCUSSION

A complete charge controller hardware setup is shown in Figure 10. Figure 11 shows the system performance with *maximum voltage for actual result. In this figure,* LCD displays maximum voltage at 14.5V for full charging of battery. While, Figure 12 shows the system performance with minimum voltage for actual result. In this figure, LCD display minimum voltage at 11.5V for recharging the battery.

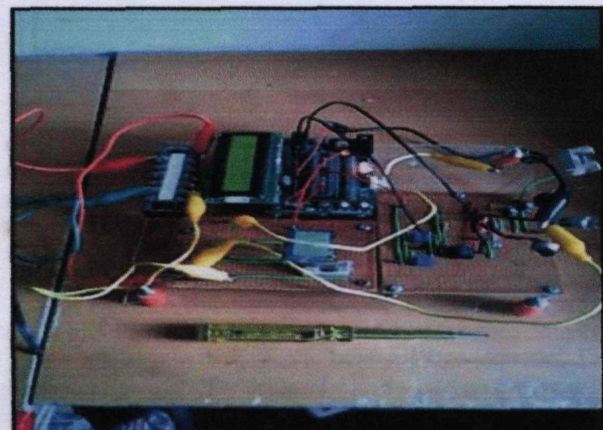

Figure 10. Charge controller Circuit design

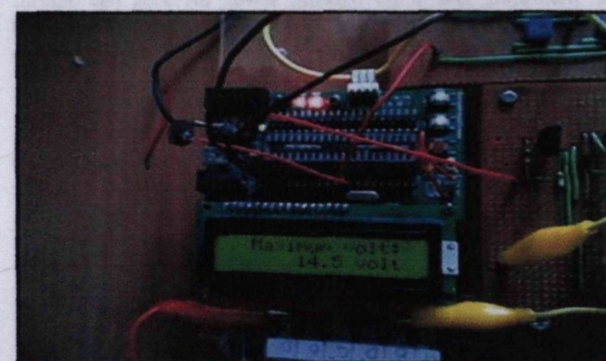


Figure 11. LCD display maximum voltage full charging

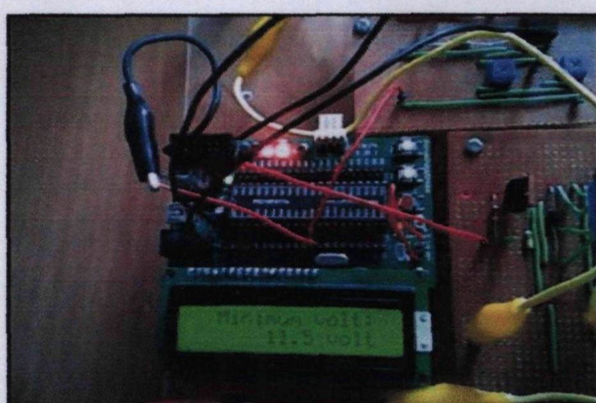


Figure 12: LCD Display minimum voltage start charging

TABLE II. EXPECTED AND EXPERIMENTAL RESULTS

| Result | | Expected | Experimental |
|---|---|---|---|
| Battery | *Start Charging* | 11.5 V | 6.0 V |
| | *Full Charging* | 14.5 V | 9.0 V |
| LED | *Start Charging* | Red | Red |
| | *Full Charging* | Green | Green |
| LCD display | *Start Charging* | Minimum volt :11.5V | Minimum volt :6.0V |
| | *Full Charging* | Maximum volt: 14.5V | Maximum volt: 9.0V |

TABLE III. EXPERIMENTAL RESULT

| Voltage(V) | Operation | Signal(LED) |
|---|---|---|
| 5.8 | - | - |
| 6.0 | Start Charging | GREEN |
| 6.4 | Charging | |
| 6.8 | Charging | |
| 7.2 | Charging | |
| 7.6 | Charging | |
| 8.0 | Charging | |
| 8.4 | Charging | |
| 8.8 | Charging | |
| 8.9 | Charging | |
| 9.0 | Full Charging | RED |
| 9.1 | Full Charging | |

Operation of this system can be divided into three major components which are generator wind turbine, microcontroller and batteries golf car. PIC16F877A has been use in this system. The overall control system by PIC16F877A was shown in Table II. From the expected result it operates for detected the maximum voltage at 14.5 volt for fully charge the battery and detected the minimum voltage at 11.5 volt for recharging the battery. When the system in condition ON, the power input from the generator charges the battery and the voltage will be increased until the LCD displays the maximum voltage on the screen and this indicates that the battery is fully charged. When fully charged, a bright green LED will turn on as a sign of the battery being charged to its full capacity. Then if voltage increased over the 14.5 volt the relay will turn OFF and the power supply will shift towards the cooling fan to avoid overcharge of the batteries.

When the voltage capacity inside the battery was dropping gradually, once voltage had reach the minimum level or recharging level, relays will automatically switch ON and the battery will be charged again. During this particular period, a bright red LED will light up and LCD screen will display the level of voltage left in the battery. This system will be rotating over and over again as long as the battery was still functional.

After applying some changes to the main circuit charge controller. There are changes that can be gathered and the experiment result is as shown in Table III. The program used to display voltage values was a success while the usage of LED signals to detect maximum and minimum voltage also proven to be successful. As shown in Table III, the battery began to be charged at 6.0 Volt and as the voltage increase gradually, the battery keeps on charging until it reaches the voltage of 9.0 Volt where the red light will light up to indicates that the battery is fully charged.

Due to several unforeseen problems and limitations in the implementation of this project, for first attempt the expected result as established in Table 2 cannot be attained. The problem that was detected during the process is the malfunctioned of main controller which is PIC16F877A due to excessive voltage. The maximum voltage the PIC16F877A can accept is 5 Volt. However, an unexpected problem occurs when the input voltage that was coming through the IC was over the 5 Volt limit.

## V. CONCLUSIONS AND RECOMENDATIONS

In this research it a new approach to design a battery charge controller was proposed and implemented. Then it has presented the function of microcontroller in the determination of the maximum or minimum output voltage to charge or discharge the battery golf car automatically based on power coming from the wind turbine.

This approach combines the Peripheral Interface Controller (PIC) and Peripheral Simulation Models were used to solve problems arising in the design of battery charge controller. The battery charge controller designed with the new approach shows good performance through computer simulations. The charging and discharging of the battery can be obtained correctly if wind turbine can generate power through the charge controller. So this project manages to fulfill the entire objective that has been discussed.

Although goods results have been attained from computer simulations and experiment testing, to make the new approach really works with the design of battery charge controller, there are several research works should be conducted in the future. The charge controller fabricated with small size, then the performance of the charge controller with real golf car. According to the test results, modify and improve the controller.

## ACKNOWLEDGEMENT

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