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A Study of Triangle Current Charge Method in Ni-MH Battery

[1]Worrapong Wongphasuk, [2]Thanarat Chawaphan, [3]Pakhinai Tepia, Atibodee Sompowtong[4]
Corresponding Author: Worrapong Wongphasuk
(Electrical Engineering Technology, King Mongkut's University of Technology North Bangkok, Thailand)

***Abstract**: This study propose the charging method from the triangle current charge method in Ni-MH battery. By using microcontroller board (PIC24FJ128GB110) to control the battery charging circuit. The charger recorded the battery temperature is lower than the current conventional battery charger. During charging, the voltage recorded current and battery temperature every second. The voltage is recorded as a condition for cutting the battery charge when the battery charging has done. There were stop charging by Negative Delta Voltage or temperature, it was done to study whether to charge the battery by using the triangle wave. As an outcome, the battery temperature during charging is lower than charging by current conventional battery charger. This will help extend the useful life of the battery longer.*

***Keywords**: Ni-MH Battery, Triangle Current Charge, Battery Charging*

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I. Introduction

Nowadays Battery is becoming more and more a part of human life. It is used as a primary energy source for electrical equipment that humans need in everyday life, such as be mobile phones, wrist watches, tablets, notebook computers, etc. These devices require the main power source, that is the battery [1].

Nickel-Metal Hydride Battery (Ni-MH) battery has been developed following the Nickel Cadmium (Ni-Cd) battery. Many features of the two kinds of battery are similar, but Ni-MH has an electrode that can store more energy than a Ni-Cd electrode. Ni-MH battery is not toxic to the environment, and cheaper. But Ni-MH battery's rate current capability is lower than Ni-Cd battery. During the development battery of mobile phone, Ni-MH battery can be used instead of Ni-Cd in many electronic devices. However, Ni-MH battery was replaced by lithium-ion(Li-ion) battery because of Li-ion battery is cheaper and more capacity. But Ni-MH still using for some electronics device, and using for electric car.

In the past, the battery is charged with a constant current, which has the disadvantage that while charging the battery temperature is quite high with this factor. The disadvantage of charging battery has developed by the use of triangle wave charging to replace the constant current to reduce the heat during charging and study the charging method that suitable for Ni-MH. The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper.

II. Main Equipment For This Study

ET-PIC 16/32 START KIT Microcontroller board

ET-PIC 16/32 START KIT is a microcontroller board for learning and development. This is compatible with the PIC24F / PIC24H / dsPIC33 and PIC32 family of 16/32 microcontrollers. Microcontroller board is designed to be easy to use and flexible, can adjust the microcontroller numbers to be installed on the board as needed. It also helps to reduce the problem in the case of microcontrollers and flash problems, memory cannot be used because out of space of the memory.

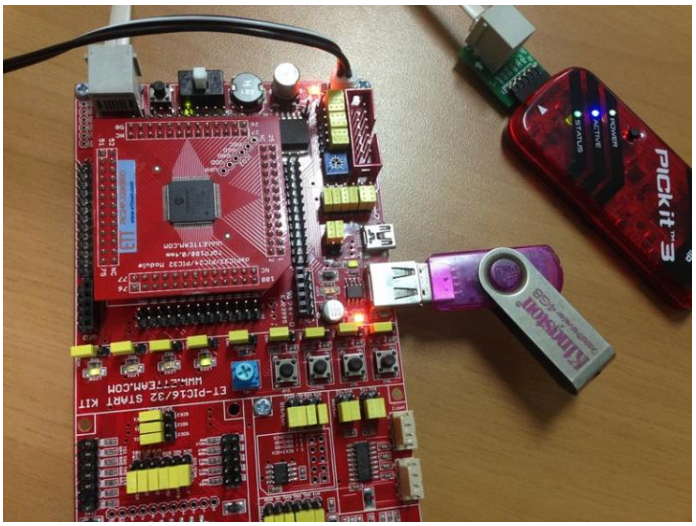

Figure: 1 application of ET-PIC 16/32 START KIT microcontroller board

PIC24FJ128GB110

PIC24FJ128GB110 used for deciding of charging (start charging) or discharging (stop charging), both processes are automatically rotated by data logger. Storing the voltage data from the battery and the temperature converted to digital data to store in the thumb drive all the time from every second of experiment. The data obtained from the experiment will be large in 1 day. That is 60x60x24 = 86,400 data (seconds) per experiment.

Ni-MH battery

Nickel-Metal Hydride (Ni-MH) battery is kind of secondary electric cells. It can be reused by fully charging after used up. Based on the principle of reverse electrolysis and hydrogenation (H). The structure of Ni-MH contains nickel oxide anode by negative electrolyte that absorb hydrogen (H) and electrolyte solution containing aqueous solution, which is mainly potassium hydroxide.

For charging of Ni-MH battery must be used all of battery cell before recharging. If there is still energy left, there will be chemical residue or precipitate in the battery cell, which results in shorter life or cannot store energy efficiently. And if the first time of using Ni-MH battery, such as when buying a new battery, it should be charging continuously for about 14-16 hours (but do not charge it over 24 hours).

Temperature sensor

LM35 is a sensor that is intended for temperature measurement, the principle of the LM35 is sent numerically to PIC24FJ128GB110. For this study, we will write code to program PIC24FJ128GB110 Convert the temperature to the value of the output from the sensor to the value of the voltage, then those values converted to temperature. Method for measure of LM35 is the value of the output voltage from sensor converted to temperature. The temperature measurement uses the variation of the voltage level from analog to digital signal, relative to the temperature LM35. Accuracy of measurements are used to measure linear voltages with temperatures in degrees Celsius.

III. Study Method

Microcontroller charging, measure and record the battery voltage by storing data at the thumb drive while charging. This study using battery charger to experiment with AAA battery, the capacity is 800mAh.

Working of the microcontroller board to store data in thumb drive

Function of microcontroller stored data and perform charging, that is automatic battery charger. Microcontroller board starts by pressing the start switch, the process starts at state 3, switch S2. The circuit will run (S1 and S3 do not work), battery connected to the R2 resistor to discharge the battery. When the battery voltage is lower than 0.8V, the system will stop stage 3 and enter to state 4, then wait 10 seconds (S1, S2, and S3 do not work). Charging start by go into state 1 with triangle current wave.

When the system found "Negative Delta Voltage" (-ΔV) or temperature of battery reaches 46°C, state 1 is changed to state 2.

When entering state 2, switch S1-S3 does not work. The system wait until the temperature of the battery is lowered or cooled down to less than 33°C, then switch to the state 3 again.

The microcontroller that control the charging or discharging of the battery change state will store the data of voltage and temperature of the battery simultaneously.

IV. Data analysis

This study presented the results of the data analysis in the form of tables and graphs. The type of data is .txt, the text file as shown in the following example.

1) Obtained information at state 3

05-05-2017,04:21:01,D,00386,00103,00105,00386
05-05-2017,04:21:02,D,00331,00103,00106,00331
05-05-2017,04:21:03,D,00329,00103,00105,00329
05-05-2017,04:21:04,D,00328,00103,00105,00328
05-05-2017,04:21:05,D,00328,00103,00106,00328
05-05-2017,04:21:06,D,00327,00103,00105,00327
05-05-2017,04:21:07,D,00326,00103,00105,00326
05-05-2017,04:21:08,D,00326,00103,00105,00326
05-05-2017,04:21:09,D,00325,00103,00105,00325

"D" refers to the battery discharge state.

2) Obtained information at state 4

05-05-2017,08:57:49,M,00290,00081,00114,00290
05-05-2017,08:57:50,M,00296,00082,00114,00296
05-05-2017,08:57:51,M,00299,00081,00114,00299
05-05-2017,08:57:52,M,00302,00082,00114,00302
05-05-2017,08:57:53,M,00304,00082,00114,00304
05-05-2017,08:57:54,M,00306,00082,00114,00306
05-05-2017,08:57:55,M,00308,00082,00114,00308
05-05-2017,08:57:56,M,00310,00082,00114,00310
05-05-2017,08:57:57,M,00311,00081,00114,00311
05-05-2017,08:57:58,M,00312,00082,00114,00312

"M" means waiting stage, from discharge status to charge battery.

3) Obtained information at state 1

05-05-2017,08:58:00,C,00391,00031,00119,00397
05-05-2017,08:58:01,C,00401,00060,00116,00385
05-05-2017,08:58:02,C,00406,00073,00110,00433
05-05-2017,08:58:03,C,00410,00052,00115,00408
05-05-2017,08:58:04,C,00414,00050,00116,00412
05-05-2017,08:58:05,C,00416,00312,00165,00428
05-05-2017,08:58:06,C,00418,00000,00165,00456
05-05-2017,08:58:07,C,00419,00046,00116,00421
05-05-2017,08:58:08,C,00421,00054,00115,00409
05-05-2017,08:58:09,C,00422,00085,00064,00454

"C" means charging state.

4) Obtained information at state 2

05-05-2017,09:55:46,N,00477,00091,00140,00477
05-05-2017,09:55:47,N,00477,00090,00140,00477
05-05-2017,09:55:48,N,00477,00090,00140,00477
05-05-2017,09:55:49,N,00476,00090,00140,00476
05-05-2017,09:55:50,N,00477,00090,00140,00477
05-05-2017,09:55:51,N,00477,00090,00140,00477
05-05-2017,09:55:52,N,00477,00090,00141,00477

05-05-2017,09:55:53,N,00476,00090,00140,00476
05-05-2017,09:55:54,N,00476,00090,00140,00476
05-05-2017,09:55:55,N,00476,00090,00140,00476

"N, T, L" means stop charging, charge state into the condition of discharge by temperature of 33°C.

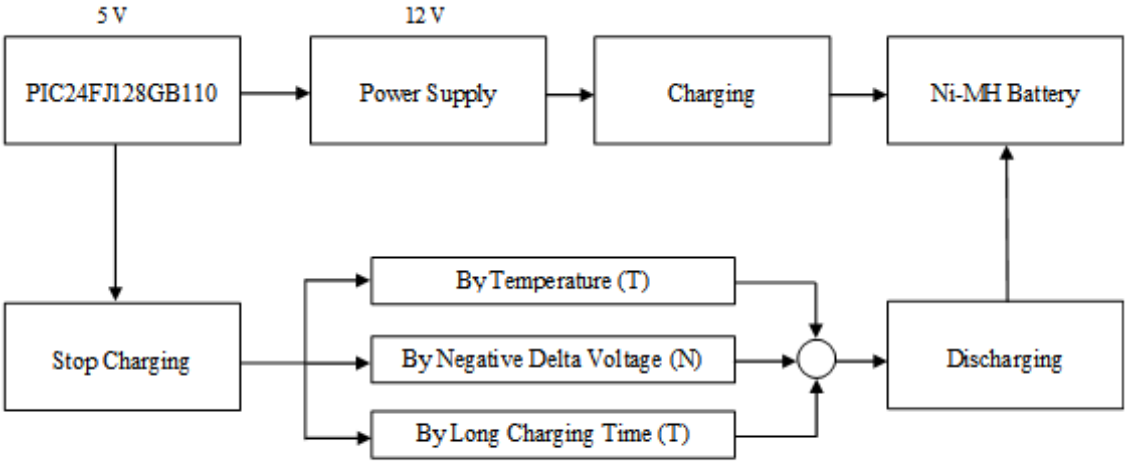

Figure 2 Block diagram of charger

Definition of information

Table 1 Table of stored data.

Date	Time	Symbols of stages	Voltage	Temperature
05-05-2017	09:55:46	State 1(C)	397	119
05-05-2017	08:57:49	State 2 (N)	477	91
05-05-2017	04:21:01	State 3 (D)	103	105
05-05-2017	08:57:49	State 4 (M)	290	114

V. Experimental Result

There are two reasons for discharging in this experiment, Negative Delta Voltage and battery temperature reached the charge setting value of 46 ° C. If temperature of battery is higher than 46°C, the system changed to discharging (State 1 to State 2). In this experiment will charge (1 hour) and discharge (1 hour) 50 times, totally 100 hours. After getting *.txt format converted to Excel data for further analysis.

The triangular waveforms of the experiment

By switching the ON-OFF switch to contain energy for the inverter (L1), the triangular waveform shown in below.

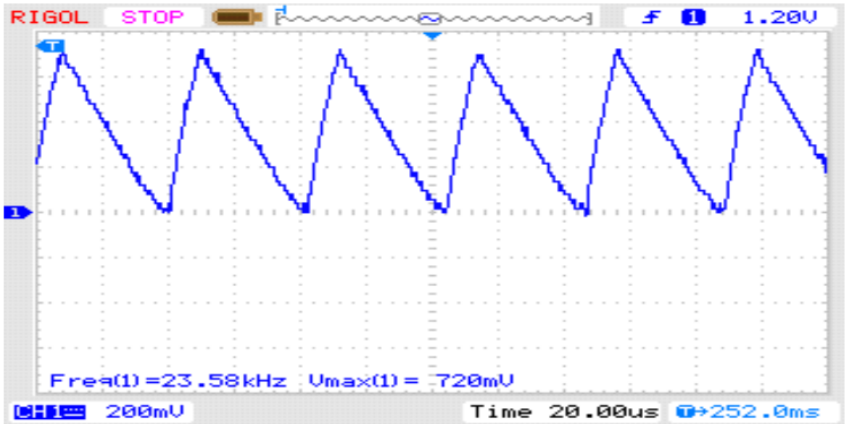

Figure: 2 Triangle waveform

From upper picture is an enlarged triangle current waveform. The charging current is 720mA, 23.58kHz.

The result of battery charging

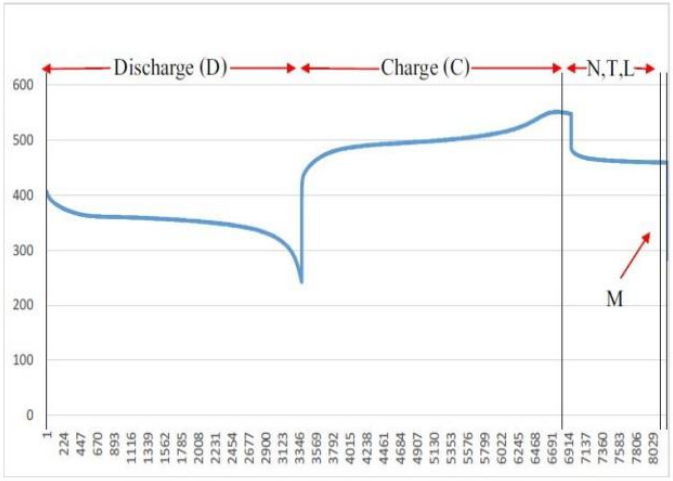

Figure: 3 Shows the status of the charger

In this experiment used AAA Ni-MH battery, 800mAh, charging current 0.8A in 5 days (25°C degrees throughout the experiment). The digital data is stored in the thumb drive. There are 6 states of charging:

C is charging by triangle current
N is waiting the temperature of battery lower than 46°C (stop charging by Negative Delta Voltage)
L is waiting the temperature of battery lower than 46°C (stop charging when charging time is more than 2 hours)
T is waiting the temperature of battery lower than 46°C (stop charging when temperature is higher than 46°C)
D is the discharge state until the battery voltage is lower than or equal to 0.8V
M is wait for 10 second break before it goes back to charging

VI. Conclusion

This experiment aims to find out the effect of charging the battery with a triangle charging current. We found that from the experiment, the almost of battery discharge was -ΔV method. This makes it possible to conclude that while charging the battery, the temperature is lower than charging with a reference charger (constant current) sold in the market. Therefore, the triangle current battery charger has the advantage of reducing the battery temperature during Ni-MH recharge.

References

[1]. Worrapong Wongphasuk, Short-time Discharge Frequency in ReFlex Charging Method in Ni-MH Battery Charger and Maximum Battery Voltage, Electrical Engineering Conference of Thailand, 34th, 2011.
[2]. David Linden, Thomas B.Reddy, Handbook of batteries (McGraw-Hill, 2001).

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