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Comparison of Wet and Dry Battery Charging to Improve Charging Time Using a Power Converter Adapter

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Abstract

In most cases, the vehicle battery has its own charging system. Battery charging generally has a cut-off system to keep the battery lasting. The emergence of manual chargers and automatic chargers still has adjustment criteria according to the type of ampere-hour (AH) and battery voltage. This research aims to create a reliable automatic and manual 12V-5Ah battery charger device capable of regulating and stabilizing current and voltage measurements for wet and dry batteries. The method used is a battery charging system tool kit assembly system with a good electrical converter system so that it can protect against noise, good electric current and unstable electric voltage from the electricity source. The voltage difference between the normal and automatic settings on the charger, when tested without load, was measured at 1.35 volts. Additionally, the frequency difference between the two states was found to be 3.30 kHz. The average voltage measured in the typical and automatic settings was 14.80 volts, and the average frequency was 8.25 kHz. For a 100% battery charging time of 120 minutes, the normal voltage produced is 13.55 volts; for 100% automatic charging conditions for 80-minutes the voltage is 13.58 volts. Under general conditions, the charging time for a completely discharged dry battery is 100-minutes, producing a voltage of 13.7 Vdc. In contrast, the charging duration for a fully automatic process is 70-minutes, resulting in a voltage of 13.73 volts dc. From the results of this research, it is hoped that IoT technology can continue to develop.

1. Introduction

In today's life, energy is increasingly needed, especially electrical energy, in daily life in households and industry, related to the development of electricity generation technology (Kim et al., 2023), (Wijaya, 2019), so that electrical energy becomes a basic need and daily mainstay. However, because current energy sources are very limited, the absence of electrical energy is inevitable, thus affecting civilization (Pasaribu et al., 2023). Therefore, it is necessary to continuously store electrical energy to meet electricity shortages that arise (Farrok et al., 2020), (Evalina et al., 2021). Electrical energy sources can be stored as batteries, in accordance with today's technical advances. With the discovery of batteries, electrical energy can now be stored to meet the electrical energy needs of people's lives (Fu et al., 2020), (Pasaribu et al., 2021).

Using batteries for long periods of time certainly requires batteries that have high energy quality so that they can be recharged in a short time and have a long life [5]. Now the battery is being developed so that it can be carried anywhere in a smaller form factor and has a larger capacity reserve that can be used as needed. As a consequence, the use of batteries as an emergency electricity source is still the mainstay of society to overcome the deficit in electrical energy needs (Farrok et al., 2020), (Badawi et al., 2019).

Batteries used for energy storage are susceptible to discharge if operated continuously without being charged, resulting in damaged/wet batteries. So in this scenario an appropriate charger is needed for charging the battery so that the energy source can be filled and is not easily damaged/wet (Wijaya, 2019). Meanwhile, the use of batteries in vehicles is supported by a separate charging system via the dynamo case and other case components (Aziz et al., 2016). Battery charging generally has a cut-off system which aims to keep the battery long-lasting (Sujitha & Krithiga, 2017). A battery charger is a device that charges direct current energy in storage media such as capacitors, batteries, and batteries (Mulyana et al., 2019). With the charging process, the battery can be charged in such a way that it can be reused and utilized as a reusable energy reserve (Pasaribu, 2020), (Khezri et al., 2020).

The battery charging technique includes using a 220 V_{AC} power source which is then reduced to 15V as the input. The negative connection of the DC (direct current) source is mounted on the negative plate called the battery anode in the charging mechanism. Correspondingly, the positive connection of the electricity source is coupled to a positive plate called the battery cathode. Based on experimental findings, the measured output voltage (V_{out}) is determined to be 12.2V, while the output current (I_{out}) varies between 0.60A and 0.90A (Bitenc et al., 2020).

The research that will be studied is different from previous research, the research that will be studied displays the feature of an automatic renewable battery charger (Chellaswamy et al., 2020), the working range is 6-105Ah, whereas previous research was not automatic, and only worked up to 80 Ah on the charger. Generally, the battery charging system for motorbike and car batteries is only a charging system (Klontz et al., 1993), without thinking about the effects of the output pulse which can damage the battery itself (Belekar et al., 2017). In this research, a battery charger model MF 2B was used which has the function of being able to charge all types of batteries equipped with an electrical converter circuit (Komathi & Umamaheswari, 2017).

2. Method

In several previous studies, battery chargers/battery systems only worked with one variable, namely working automatically and some only worked manually by monitoring the duration of charging hours (not automatically) and only up to 80Ah. In general, the system for charging motorbike and car batteries is only limited to filling the voltage capacity of each type of battery (Badawi et al., 2019), (Hanifah et al., 2019), regardless of frequency. With problems that usually occur, without thinking about the effects of the output pulse which can damage the battery itself.

This research uses research methodology to develop and apply manual and automatic charging methods as shown in Figure 1 which consists of a transformer, bridge diode, relay, inverter kit (Evalina et al., 2021), and converter kits (Raju & Ray, 2021), Next, experimental tests and measurements are carried out, so that direct measurement data is obtained. By measuring current and voltage within a certain period of time (Zhu et al., 2020)and see the pulse wave (using an oscilloscope measuring instrument), at the output of the charger which is also connected to a wet battery or dry battery (Singh et al., 2021), (McKeon et al., 2014).

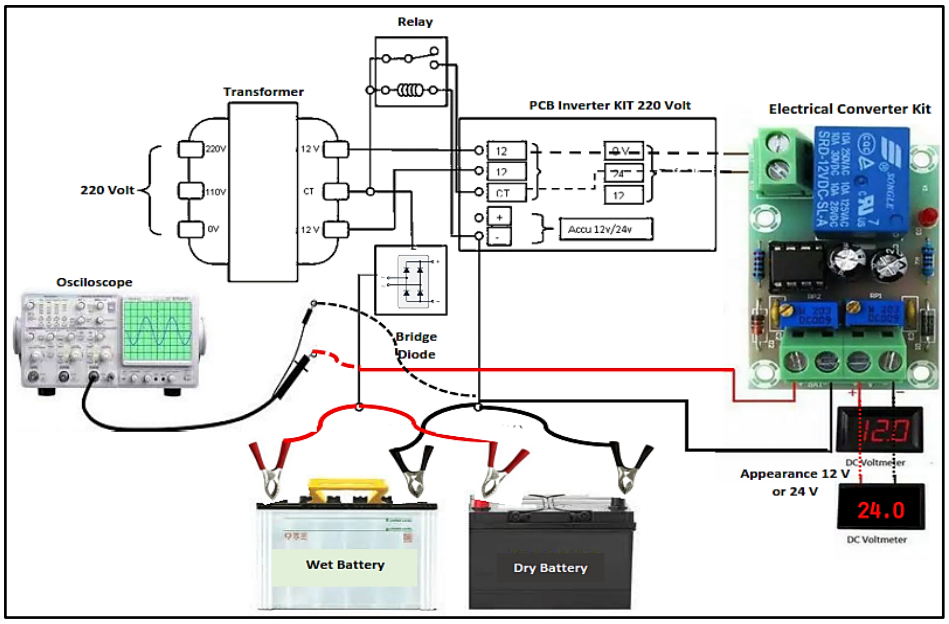


Figure 1. Design/assembly of Wet Battery and Dry Battery Charging systems

Research methods in research topics or what is the main topic of a research. This research looks at and can describe the steps, the research object or variable is analyzing the charging process and the output pulse waveform on the battery charger, with variables; Battery charger voltage input from voltage source; Knowing the voltage coming out of the battery charger before and after charging the battery; Calculate the difference in frequency and voltage for each condition on the battery charger (Zheng et al., 2016), (Mahfurdz & Sunardi, 2015). Observe the output pulse waveform using an oscilloscope before and after charging the battery.

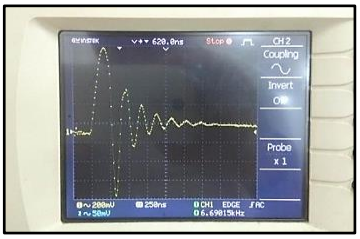
3. Results and Discussion

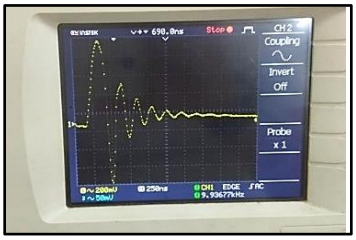
3.1. Battery Charging Circuit Output Measurement

In this experiment, a battery charger was used that had been assembled with manual and automatic charging conditions. Manual charging has a current capacity of 1.5A, while automatic charging has an electric current capacity of 3A. The measurements carried out are measuring the output voltage of the battery charger in Manual condition and Automatic condition (Benshatti et al., 2020), (Wood et al., 2011). The measurement uses a digital multimeter which is used to detect the charger output voltage, and an oscilloscope to determine the frequency and waveform of the battery charger. Testing in this study used different times because it adjusted to the condition of the battery type. For wet batteries, the charging process is faster than dry batteries. Based on the results of these

measurements, as listed in Table 1, the following findings were obtained.

Table 1. Charger testing without load.

No.	Charger without load Manual condition		
1	**Voltage**	**Chart**	**Data**
	14.21 Vdc		Vp-p = 7.8 V High five = 2 V/div = 200 mV T/div =250 ns Frequency = 6.6 kHz

N	Charger without load Automatic condition		
2	**Voltage**	**Chart**	**Data**
	15.56 Vdc		Vp-p = 7.9 V Tosc = 1.4 V/div = 200 mV T/div =250 ns Frequency = 9.9 kHz

From the measurement data in manual mode, the charger output voltage is 14.21V and the operating frequency is 6.6kHz, while in Automatic mode, the output voltage is 15.56V and the frequency is 9.9kHz. As a result, data on the difference, average voltage and frequency between Manual and Automatic conditions were obtained.

As a result, the difference in voltage between Manual and Automatic states is 1.35V, with a frequency difference between Manual and Automatic states of 3.3kHz. Manual and Automatic settings have an average voltage and frequency of 14.80V and 8.25kHz respectively.

3.1.1. Testing the Battery Charger with Wet Battery Loading, under Manual Conditions

Charging takes 12 to 120 minutes based on test findings for the 12V-5AH wet battery in Table 2 and the initial state of the 10V wet battery. This test determines how long it takes to fully charge the power source in manual settings.

Table 2. Wet Battery Charging Times in Manual Settings

No.	Time (Minutes)	Voltage
1	12	12.70
2	24	12.77
3	36	12.84
4	48	12.92
5	60	13.00
6	72	13.08
7	84	13.16
8	96	13.25

9	108	13.38
10	120	13.55

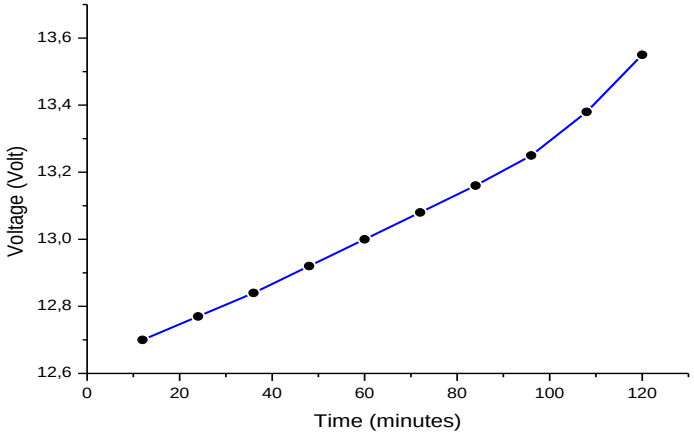


Figure 2. Graph of time to wet battery voltage in Manual Settings.

Based on the load test results shown in Table 2, the experiment was carried out at a scheduled time of 12 minutes, producing the following types of data: after 12 minutes, the battery charged to 10% had a voltage output of 12.70V; after 60 minutes of charging, the 50% charged battery has an output voltage of 13V; and after charging for 120 minutes, a 100% charged battery has an output voltage of 13.55V. Based on the results of manual battery charging testing, a graph can be created showing the relationship between battery charging time and voltage, as shown in Figure 2.

3.1.2. Test the Battery Charger on Auto Settings using a Wet Battery

The purpose of this test is to determine the time it takes for the battery to fully charge when using automatic settings. Table 3 shows the data collected based on test findings. The test results on a 9 Volt battery condition show that, because the test is carried out every 8 minutes, the data obtained shows that after 8 minutes it produces a voltage of 12.73V, when the cell is 10% charged, and at the 40th minute, it produces a level of 13. 11V. The cell has a charge of 50%, and after 80 minutes, produces an electrical voltage of 13.58V, which indicates that the cell is fully charged (100%). Based on the results of the automatic battery charging test, an overview of the time spent on charging and power on the battery can be produced in Figure 3, which clearly shows the lines or time points, and the voltage shows a value that is faster in the charging process compared to the voltage. test graph in Figure 2.

Table 3. Wet Battery Charging Time on Automatic Settings

No.	Time (Minutes)	Voltage
1	8	12.73
2	16	12.89
3	24	12.98
4	32	13.01
5	40	13.11
6	48	13.24
7	56	13.31
8	64	13.42

9	72	13.50
10	80	13.58

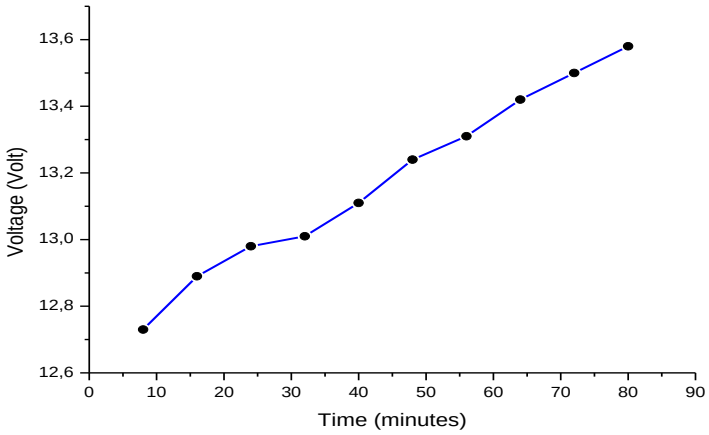
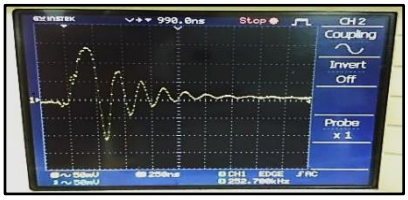
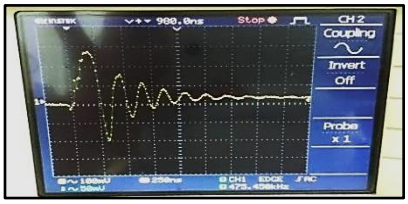


Figure 3. Graph of time versus wet battery voltage in automatic condition.

Table 4. Testing the charger with a wet battery load.

No.	**Charger with manual battery charge**		
	Voltage	**Chart**	**Data**
1	13.60 V		Vp-p = 5.3 V Tosc = 1.5 V/div= 50 mV T/div = 250 ns
	Charger with automatic load condition		
	Voltage	**Chart**	**Data**
2	14.80 V		Vp-p = 4.8 V Tosc = 1.5 V/div=100 mV T/div = 250 ns Frequency=475

Based on the measurement results in Table 4, the final output voltage of the charger when loaded with a wet battery in manual mode is 13.60V_{DC} and has a frequency of 252kHz. Meanwhile, the voltage is 14.80volt direct current. and the peak frequency is 475kHz in automatic settings. The data is then analyzed to determine the differences and average frequency and voltage between Manual and Automatic settings. Therefore, the voltage variation between Manual and Automatic conditions is 1.2V, while the frequency difference between Manual and Automatic conditions is 223kHz. In addition, the median voltage for manual and automatic settings is 14.2V, in both human and automatic states, the average frequency is 363.5kHz.

3.2. Battery Charger Charging with Dry Batteries

A. Manually Charge the Battery Charger on a Dry Battery

Further research and testing used a 12V–5AH dry battery. This test was carried out to find out how long it takes to fully charge the battery in manual and automatic conditioning settings. The test data in Table 5 are manual conditions measured every 10 to 100 minutes.

Table 5. Battery Charging Time for Dry Batteries in Manual Conditions

No.	Time (Minutes)	Voltage
1	10	11.50
2	20	12.00
3	30	12.82
4	40	12.90
5	50	13.00
6	60	13.15
7	70	13.28
8	80	13.41
9	90	13.54
10	100	13.70

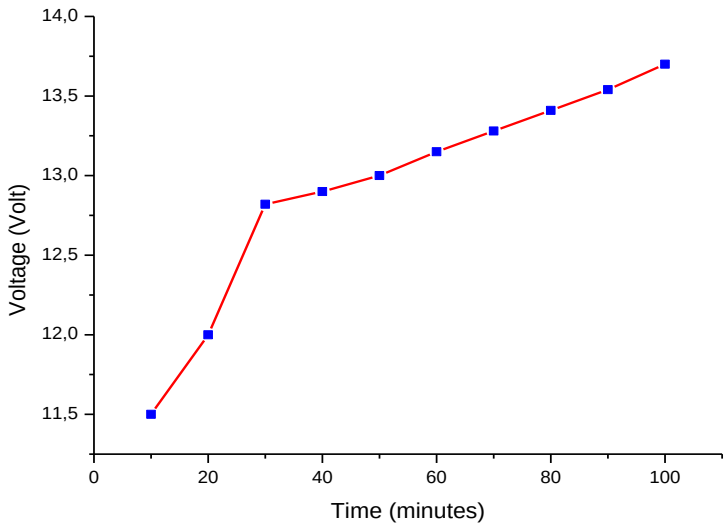


Figure 4. Graph of battery dry time and voltage in manual mode

Based on the test load findings, it can be seen that the experiment was carried out at regular intervals of 10 minutes. The recorded data revealed that after 10 minutes, the output voltage reached 11.5V, indicating a battery charge level of 10%. Similarly, after 50 minutes, the output voltage increased to 13V, indicating a charge level of 50%. Finally, at minute 100, the output voltage reaches 13.70V, indicating the battery is fully charged with 100% capacity. A graphical representation illustrating the relationship between the battery charging duration in manual conditions and the corresponding voltage level can be generated based on the test results obtained, as seen in Figure 4. As seen in Figure 4, the battery charging rate increases at a regular rate, at a rate of every ten minute. The lowest voltage when charging for a 10-minute period is 11.50V, and the maximum voltage when

charging for 100 minutes is 13.70V.

B. Battery Charger Testing on Dry Batteries in Automatic Mode.

This test is repeated to assess how long it takes to fully charge the battery in Auto. The following data, as shown in Table 6, comes from test findings. The results of the load testing show that the test is carried out every 7 minutes, so that the data obtained at the 7th minute produces a voltage of 11.70V, the energy source is 10% charged, 50% charged after 35 minutes, and 100% charged after 70 minutes if the output voltage is given 13.73V. A graph relating time and voltage to the battery can be generated using the battery charging test results in automatic settings, as illustrated in Figure 5. In Figure 5, it can be seen that the battery charge increases regularly during the test every 7 minutes. After charging for 7 minutes, the voltage becomes 11.70V, while charging for a total of 70 minutes, the voltage becomes 13.73V.

Table 6. Battery Charging Time The battery is dry in automatic condition

NO.	Time (Minutes)	Voltage
1	7	11.7
2	14	12.00
3	21	12.31
4	28	12.75
5	35	13.26
6	42	13.34
7	49	13.47
8	56	13.53
9	63	13.65
10	70	13.73

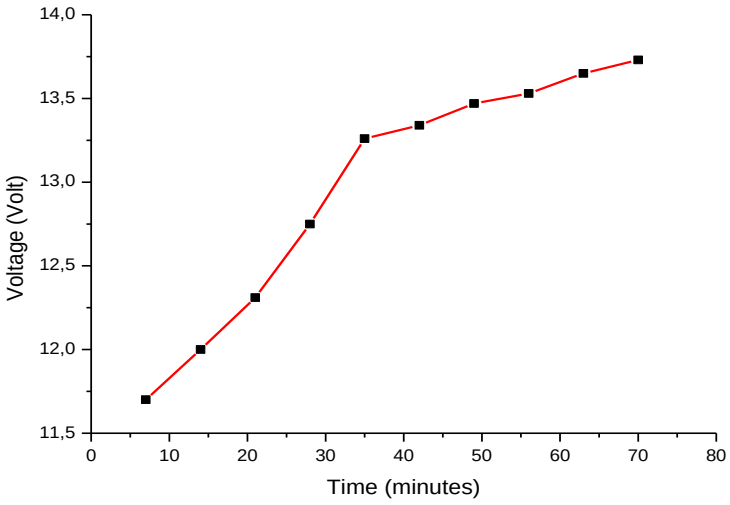
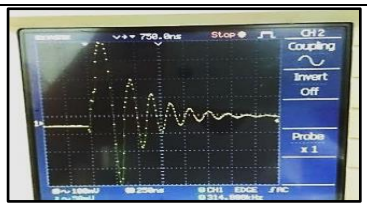


Figure 5. Graph of time and dry battery power in automatic state.

Table 7. With a dry load, test the charger.

No.	Charger with manual battery charge		
	Voltage	**Chart**	**Data**
1	13.40 V		Vp-p = 5.2 V High five = 2 V/div = 50 mV T/div = 250 ns Frequency = 286 kHz
	Charger with automatic load condition		
	Voltage	**Chart**	**Data**
2	14.55 V		Vp-p = 8 V Tosc = 1.5 V/div = 100 mV T/div = 250 ns Frequency = 346 kHz

The test results show that the output voltage of the charger filled with wet batteries in manual conditions is 13.40Vdc and a frequency of 286kHz. Meanwhile, in automatic conditions the voltage is 14.55Vdc and the frequency is 346kHz. Then the difference data and average values of voltage and frequency seen in Manual conditions were obtained compared with those observed in Automatic conditions. The experimental results show that there is a voltage difference of 1.15V and a frequency variation of 60kHz in Manual conditions and Automatic conditions. The average voltage in the Manual and Automatic conditions was found to be 13.9V, while the average frequency in the Manual and Automatic conditions was set at 316kHz.

4. Conclusion

The test results were obtained from checking the charge of the Wet Battery and Dry Battery, taking measurements(Benshatti et al., 2020),(McKeon et al., 2014), can be concluded that:

- 12V–5Ah charging system, the use of wet and dry batteries varies, because the battery type code adapts to the load and device being tested.
- The results of the free charger showed a voltage difference of 1.35V and a frequency difference of 3.30kHz between normal and automatic conditions. The average difference in voltage and frequency between normal and automatic conditions was 14.8V and 8.25kHz respectively. .
- For 100% wet battery charging conditions for 120 minutes, under normal conditions the voltage produced is 13.55V_{dc}, while under 100% automatic charging conditions for 80 minutes the resulting voltage is 13.58V.
- Under 100% dry battery charging conditions, the battery charging time is 100%, normal conditions are 100 minutes, the resulting voltage is 13.70V_{dc}, while the 100% automatic charging time is 70 minutes with the resulting voltage being 13.73V.

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Conflicts of Interest

The writers have disclosed no conflicts of interest.

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