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Battery Charger Regulator with Fully Controlled Rectifier 15 V / 5 A On Uninterruptable Power Supply

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Abstract
Fully controlled rectifier and Battery Charge Regulator (BCR). BCR is the main unit of UPS (*Uninterruptable Power Supply*) equipment. The fully controlled rectifier has the function of supplying voltage directly to the BCR, and the BCR has the function of regulating the battery charge. Forced charging the battery at a constant voltage with a current that matches the life of the battery will have an impact on decreasing battery life, besides that it will have an impact on the efficiency of using the battery. Controlling the input voltage of the charging battery as a function of the battery voltage is regulated by the magnitude of the charging current flow. Charging the battery via BCR is adjusted to the battery voltage so that BCR can control it by adjusting the voltage to 13.5 V for High Voltage Disconnected (HVD) and 10.5 V for Low Voltage Disconnected (LVD). Based on the test results of the performance of the full control rectifier system and BCR on a 12 V battery with a capacity of 5 Ah, it shows that the output voltage is A fully controlled 12 V rectifier, the BCR can charge an empty internal battery in a few minutes with a current varying from 2 .1 A to 0.1 A.
Keywords: Rectifier, BCR, Regulator, UPS

Introduction
Special computers or electronic devices require a continuous power supply (Cho et al., 2015). Uninterruptable Power Supply (UPS) is an electric power supply system capable of supplying electrical power quickly when it is needed at the right time so that the impact of data loss can be avoided (Billings & Morey, 2011). The main component to support the work of the UPS is the rectifier system as a battery charger so that the inverter can provide alternating electric power when there is an interruption in the electricity supply from PLN. Generally, a UPS consists of an inverter, battery, battery charger, battery charger control circuit, stabilizer, switch, and indicator (Sankaran, 2017). The battery charger control circuit, also known as the BCR, functions to control the battery charging process. When the battery is fully charged, the control system will issue a command to stop the battery charging sequence. Conventionally a rectifier circuit uses a diode bridge system and the BCR is only needed as an electric circuit breaker when the battery voltage reaches 12 Volts (Chen et al., 2021). The design of a fully controlled rectifier and BCR aims to produce a control voltage and quantity at a current that corresponds to the increase in battery voltage (Al Mamun et al., 2015).

A fully controlled rectifier and Battery Charger Regulator (BCR) are the main components of Uninterruptable Power Supply (UPS) equipment. The fully controlled rectifier functions to supply voltage directly to the BCR, which functions to regulate the charge to the battery. Charging the battery forcibly at constant voltage with a current that matches the battery resistance will have an impact on decreasing battery life, in addition to the effect of high evaporation of battery fluid. Controlling the battery input voltage at the time of charging as a function of battery voltage will regulate the amount of charging current flow (Zhou et al., 2020). Through these constraints, a Silicon Controller Rectifier (SCR) is used, namely Thyristor where the gate can be adjusted by changing the angle α to be able to adjust the voltage (Boyle et al., 2020). Based on the problems and explanations above, the authors are interested in discussing and taking the title " **Battery Charger Regulator with Fully Controlled Rectifier 15 V/5 A On Uninterruptable Power Supply** ".

Literature Review
Uninterruptable Power Supply (UPS) is a backup energy system that is used when the main power supply fails (Qi et al., 2019). *Uninterruptable Power Supply* (UPS) can be used as a backup source of electrical energy at home when a power outage occurs by PLN (Liu et al., 2019). This UPS device can be used to protect all types of electronic equipment that are sensitive to current and voltage instability. The UPS consists of an inverter circuit that can convert DC voltage to AC voltage (Tina et al., 2019). Battery Charger Regulator is an electronic circuit that regulates the process of charging a battery or battery bank (*Battery Bank*) (Hou et al., 2019). The DC voltage that comes out of the thyristor or *rectifier circuit* varies from 12 volts up (Sciences & Journals, 2016). This controller functions as a battery voltage regulator so that it does not exceed its power tolerance limit. In addition, this regulator also prevents the entry of excess voltage into the battery. If the battery or battery pack is fully charged, the DC current from the rectifier is cut off causing the battery to no longer charge thereby preventing

battery damage and extending battery life. Thyristors are formally known *as Silicon Controlled Rectifiers* (SCR) (Nasution et al., 2020). A thyristor is one of the important semiconductor devices for controlling and breaking small and large alternating currents. Thyristors have the convenience of influencing alternating current rectifiers to direct current and vice versa, namely changing from direct current to alternating current. If the anode is more positive than the cathode, it is a junction (Mubarak et al., 2020) (Van Dalen et al., 2004). Whereas J1 and J3 are forward biased while the J2 junction is backward biased so that at that time only a very small current (leakage current) flows from the anode to the cathode. This condition is called the forward blocking state or the off state and the current flowing is called the off state (ID) current. If the voltage between the anode and cathode is increased to a certain extent, at J2 the reverse bias will experience a breakdown, and the pressure at that time is called the forward breakdown voltage (VBO). Since J1 and J3 are still in a further biased state, current will flow from the anode to the large cathode across the three junctions J1, J2, and J3. At that time the SCR is conducting or in a conducting state (in a conducting state). the voltage between the anode and cathode is very small (± 1 Volt), or decreases from a voltage sufficient to penetrate. On, the anode-cathode current depends on the load current (load impedance). The characteristics of the thyristor can be seen in Figure 1 below.

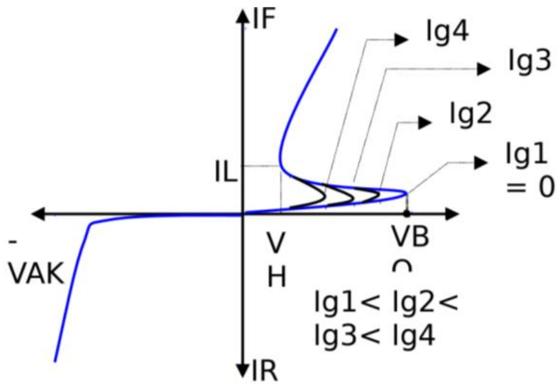

Figure 1. Thyristor Characteristics

A battery is a device that is used to store electrical energy in a chemical form which is then converted into electrical energy to obtain the required electric current so that it can be used to turn on the necessary equipment, such as electric generators, rice cookers, engine drivers and others (Lukman et al., 2020) (Triono et al., 2018). other electronic devices. A transformer or what is often called a transformer is an electrical component that can be connected to an electrical network that has a wide voltage range so that electrical power can be distributed widely and functions to change (increase/reduce) alternating voltage (AC). Regulator IC 7812 is an IC specifically designed as a voltage regulator to produce a stable 12-volt output voltage. An electrolytic condenser (*electrolytic condenser*) is a type of tubular condenser (Rofandy et al., 2022). Relays use electromagnetic principles to move the switch contacts so that with a small electric current (*low power*) they can conduct electricity with a higher voltage. The transistor is a semiconductor electronic component that has 3 electrodes namely the Base, Collector, and Emitter. This component functions as an amplifier, separator and connector (*switching*), voltage stabilization, signal modulation and many other functions. A zener diode is a diode which has the property of transmitting an electric current flowing in the opposite direction if the applied voltage exceeds the "breakdown voltage" or "Zener voltage" limit. Resistors are electronic components that have two pins and are designed to regulate voltage and current. A button switch or push button is a simple tool/switch that functions to connect or disconnect the flow of electric current with a *press unlock system* (Chen et al., 2021).

Materials & Methods

The first research phase was carried out to describe the activities used by the author so that the research was more conceptual and more structured, so the author made a flowchart which can be seen in **Figure 2.**

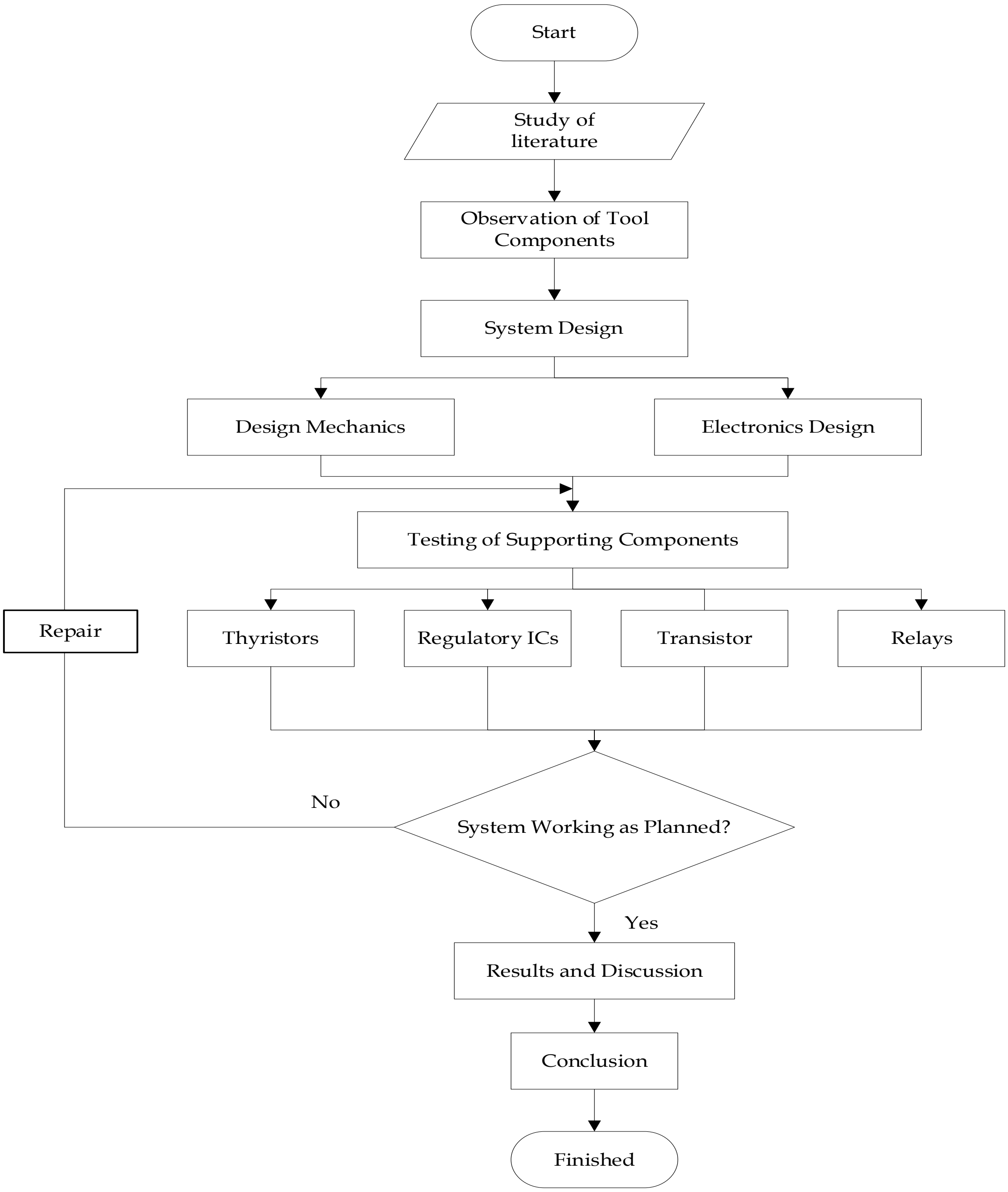

Figure 2. Research flowchart

Figure 2 is a flowchart of the research process which can be described as follows:

1. Identification of visible problems related to the BCR review process resulted in problems related to voltage regulation and battery discharge cut-off. The next step is to collect the data needed in making tools to address the above problems.
2. Literature study, after identifying the problem, the next step is to conduct a literature review concerned with the problem to be discussed and ensure that the research can be carried out.
3. Observation of tool components, namely conducting and determining component problems and the needs of the research to be carried out aims to find out the basic needs of the research.
4. System design, namely designing and assembling a planning picture of the system consisting of a mechanical design and an electronic design.
5. Testing the entire system, after the system design has been carried out, testing is carried out by running the system that has been made with certain scenario guidelines to see the success rate of the entire system design. If an error occurs or the results of the work of the system are not as expected, corrections and improvements are made to achieve the objectives of the research.
6. Results and discussion, namely the presentation and discussion of the results obtained during the testing and implementation of the system design on the UPS.
7. Conclusion, namely concluding the results of research that has been done.

Results and Discussion

The design of battery regulator charger has been designed and has been carried out at the testing stage. The testing phase is carried out first by carrying out functional tests and performance tests on all components to determine the level of success and accuracy of the system's work. After testing each component and functioning properly, it can be operated like a battery charger regulator on the UPS. The BCR system on the UPS is used as a battery charging regulator. In addition, the BCR system can also be used as a good AC/DC converter for electronic equipment at home. The data from the battery charger regulator test results can be discussed to be used as a reference in concluding.

Table 1. Thyristor Test Results

No	*Inputs*	Corner	output	
			V	I
1	15 Volts AC	15°	10.58 Volts AC	0.1058 A
2	15 Volts AC	30°	10.45 Volts AC	0.1045 A
3	15 Volts AC	45°	10.10 Volts AC	0.1010 A
4	15 Volts AC	90°	7.49 Volts AC	0.0749 A
5	15 Volts AC	180°	3.18 Volts AC	0.0318 A

From the results of the thyristor test, it is found that if the ignition angle is large, the value of the output voltage and current coming out of the rectifier circuit will be smaller, so the relationship between the *trigger angle* and the value of the voltage and current is inversely proportional.

Table 2. Battery Charging Test Results

No	Input Voltage	Current	Battery Voltage	Charging Status	Time (Minute)
1.	12.11V	2.04 A	10.12V	ON	0
2.	12.20V	2.02A	10.34V	ON	60
3.	12.39V	2.01A	10.45V	ON	120
4.	12.48V	2.0 A	10.60V	ON	180
5.	12.56V	1.8 A	10.70V	ON	240
6	12.72V	1.6 A	11.30V	ON	300
7	12.77V	1.4 A	11.45V	ON	360
8	12.90V	0.55 A	11.66V	ON	420
9	13.1V	0.45 A	11.76V	ON	480
10	13.20V	0.36 A	11.89V	ON	540
11	13.43V	0.22 A	12.00V	ON	600
12	13.45V	0.10 A	12.09V	OFF	719

From the results obtained through testing the battery charging using a battery charger regulator, whose input voltage is 12.11 Volts to 13.45 Volts, it can fully charge the battery using nearly 12 hours with a 12 V / 5 Ah battery specification. In Table 5 we can see that the current value is decreasing and the voltage value is increasing, the battery charging status is ON when the current range is in the *range of* 2.04 A to 0.22 A and the voltage is 10.12 V to 12.00 Volts and Charging will stop when the current reaches 0.10 A and the battery voltage is 12.09. This is due to the *relay* breaking the charging contacts on the battery, which is IC 7812 which regulates the voltage and the *relay* acts as a charging voltage breaker.

Conclusions

The conclusions from the research results of the Battery Charger Regulator with a fully controlled rectifier 15 V / 5 A on an *Uninterruptable Power Supply* are as follows:

1. The design and manufacture of a Battery Charger Regulator with a fully controlled rectifier 15 V / 5 A on an *Uninterruptable Power Supply* have been successful and are following the initial goal of being able to regulate the charging voltage and automatic cut-off of the battery.
2. Based on the test results of the performance of the BCR system, the use of a fully controlled rectifier in the BCR system functions to change the AC voltage from the source (PLN) to DC whose output can be adjusted from 0-12 Volts to then be input for charging the battery.
3. Regulator IC 7812 regulates the voltage rather than charging the battery does not exceed a predetermined limit.

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