JURTEKSI (Jurnal Teknologi dan Sistem Informasi) ISSN 2407-1811 (Print)
Vol. VIII No 1, Des 2021, hlm. 103 - 110 ISSN 2550-0201 (Online)
DOI: https://doi.org/10.33330/jurteksi.v8i1.1305
Available online at http://jurnal.stmikroyal.ac.id/index.php/jurteksi

UTILIZATION OF BOOSTER CIRCUIT JOULE THIEF FOR GARDEN LIGHTING SOURCE OF VOLTAGE FROM THE SUN

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Abstract: Garden lighting from a sun source utilizes a series of joule thieves so that the lighting of the garden lights at night is bright. This research method uses a quantitative method because it must be tested on each module so that it finds that there are three types of module systems to be combined, the booster or joule electronic thief module, the supply media solar module circuit, and finally, the control system with the Arduino nano board. The solar module used is a 1-watt solar module with 1n4004 diodes, which will convert the heat of sunlight into voltage. The voltage will be sent via the IC TP4056 input, the output from the IC TP4056 will charge the 18650 battery, which aims to ignite the booster circuit on the 12 W lamp, or the 3.7VDC input from the 18650 battery capable of turning on the 12W/220VAC led light. While the controller is connected to the LDR sensor and relay when the user makes the command, LDR > 800 of the provisions, the relay position from NC becomes open, or during the day, the relay will be in the NC position and turn off the 12W light in the booster circuit, while at night the relay will remain in the no position, so that it will connect the booster circuit voltage and turn on the 12W lamp (LDR < 800).

Keywords*:* booster circuit; campus park lighting; solar panels

Abstrak: Penerangan taman dari sumber matahari memanfaatkan rangkaian joule thief agar penerangan lampu taman pada malam hari terang. Metode penelitian ini menggunakan metode kuantitatif dikarenakan harus diuji coba pada tiap modul, sehingga mendapati ada tiga jenis sistem modul yang akan digabungkan, modul elektronika rangkaian *booster* atau *joule thief*, rangkaian modul surya media pensuplly, dan terakhir sistem controller dengan board arduino nano**.** Modul surya yang digunakan modul surya 1 watt dengan dioda 1n4004, akan mengubah panas cahaya matahari menjadi tegangan . Tegangan akan dikirimkan melalui input IC TP4056, output dari IC TP4056 akan mengisi baterai 18650 yang bertujuan sebagai penyala rangkaian booster pada lampu 12 W, atau input 3.7VDC dari baterai 18650 mampu menyalakan lampu led 12W/220VAC. Sementara controller terhubung kesensor ldr dan relay, ketika perintah yang dibuat oleh user, ldr > 800 dari ketentuan, posisi relay dari nc menjadi open, atau siang hari, relay akan diposisi nc dan mematikan lampu 12W pada rangkaian booster, sementara jika malam hari relay akan diposisi no, sehingga akan menghubungkan tegangan rangkaian booster dan menyalakan lampu 12W (ldr < 800).

Kata kunci : panel surya, penerangan taman, rangkaian booster.

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INTRODUCTION

The government has issued Presidential Instruction No. 10/2005 on energy-saving following the fuel supply crisis in 2005. In 2006, through Presidential Regulation no. 5/2006, the government issued a national energy policy (KEN), which is a revision of the 2004 KEN. The KEN aims to direct efforts to realize domestic energy supply security, optimize energy production, and carry out energy conservation. One form of energy conservation is the use of solar panels.

Several studies that discuss solar panels in energy conversion and supporting modules include Installing street lighting based on solar power plants (PLTS) in Gentian Village, Purwosari Village, Tegalrejo District, Magelang Regency [1]. Analysis of lighting installations using solar panels for DC-led lamp loads [2]. Prototype of Solar Panel Voltage Monitoring System (Solar Cell) in Street Lighting Based on Web Application [3]. Control of solar lighting as an implementation of community electricity [4]. Prototype of automatic garden lighting using Arduino Uno [5]. Design public street lighting (PJU) using android-based solar panels [6]. Design automatic solar cell garden lights to use the Arduino Uno microcontroller [7]. Calculation of Street Lighting Based on Solar System [8]. A booster converter circuit and ic-tp4056 for cheap street lights [9]. Joule thief as an LED power boost converter using Seawater Based Voltaic Cell [10].

A solar panel consists of solar cells that convert light into electricity. They are called the Sun above the Sun or "sol" because the Sun is the most vital source of light that can be utilized. Solar panels are often called photovoltaic cells, and photovoltaic can be interpreted as "light-electricity" [12]. To create an extensive solar panel input system and the smallest output, it is better to use a voltage amplifier circuit.

Joule thief is a series of coercive or energy thieves. Joule thief is also sometimes referred to as a simple transistor blocker circuit that can increase the energy value many times by utilizing several working principles of electronic components. However, the joule thief circuit's input is much smaller than the output it generates. The joule thief circuit itself is very suitable and reliable to increase production in the form of voltage. [14].

This study will design a tool that saves lamp power use by utilizing a joule thief circuit. An Arduino-based 5V USB Module is applied as a garden lamp so that the small input from the 18650 battery supplied from the solar module, the voltage is increased by the joule thief circuit module or booster to turn off the light load. At the same time, the Arduino controller functions to give orders to condition the sensors so that the park lights turn off automatically during the day and vice versa at night; the garden lights turn on automatically.

METHOD

The completion of this research has several stages of the process, starting with the search for literature on the working principle of the joule thief. These components make up the joule thief circuit, calculating the input and output joule thief. After that, search for literature about the solar module or panel that will be used, whether the input received by the solar panel can charge the battery quickly, and also whether the

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booster circuit can increase the battery voltage, thus forming a DC to AC voltage change system, thus spurring it to a 220VAC voltage. To turn on the light.

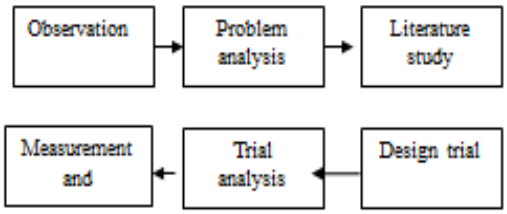

Figure 1. The research process in the field

Arduino Nano

Arduino nano is one of the Arduino board controller manufacturers with the mini category. For the controller, type 328 is used for the 3. x version and 168 for the 2. x version. Arduino nano has the same type as the Duemilanove but differs in size and circuit design on the PCB. For power on the Arduino nano does not have a power supply [15].

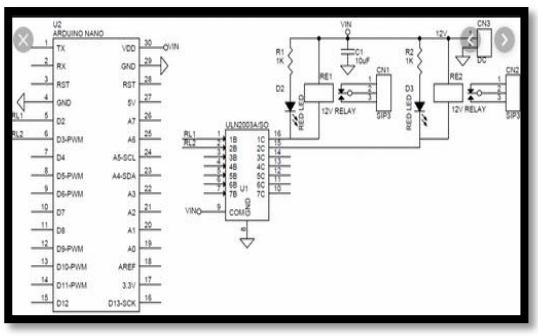

Figure 2. Scematik Arduino Nano

Solar Panel 1 Watt

The 1-watt solar module uses a heating element cell that can absorb heat into electricity. Solar panels or solar or photovoltaic modules can be interpreted as electric light. The photovoltaic function is to drink the Sun so that current can flow between two oppositely charged layers. Currently, the use of solar panels in the field is very little and is used as a source of electricity due to the high cost per watt compared to fossil fuels, which are ten times higher depending on the situation. [16].

Figure 3. 1-watt solar module used in research

LCD 1602+I2C

Liquid Crystal Display or LCD is an information display or output that uses liquid crystal to display information. LCD has been widely used in various fields in the industrial sector and the like such as TV electronic devices, calculators, and others. In this study, the LCD type used was 1602[17].

Modul USB 5VDC/TP4056

The 5V USB module is used to supply a lithium battery (Li-ion rechargeable battery) with a current of 1 ampere. Two indicator lights have a status condition during the charging process or the entire situation. The 5V USB module uses an Integrated Circuit (IC) type TP4056 which works as a linear charger for a single cell type lithium-ion battery with a constant current and voltage that has a temperature regulation or thermal regulation. For a continuous charger voltage of 4.2 V with an accuracy of ± 1.5%, the size of the battery to be charged is 3.7 VDC. Other functions of the TP4056 IC are current monitoring, under-voltage lockout, automatic recharging of the storm, and two status pins that can be filled by a led indicator or battery [8].

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Trafo

Transformers generally utilize electromagnetic principles and only work on AC (Alternative Current) voltages. The transformer was used as a type of transformer taken from a former Oppo cellphone charger in the research carried out. For other components using standard electronic components, the SCR used tip 41 [20].

Picture 4. The mini transformer used for cellphone charger

Electronic components

Electronic components for forming voltage amplifier circuits,

Capacitor

In general, the workings of capacitor devices in these various applied applications detect changes in capacitance that occur. In capacitor devices, the charging position or charge will produce a graph of the voltage that rises until it reaches a stable condition. The function of emptying or discharge will create a downward chart [21].

Transistor

A transistor is an electronic component that is classified as a semiconductor. Sometimes the transistor is used as an amplifier, up to a switching system using the principle of an electric faucet. Based on input on current (BJT) or voltage on input (FET) allows a very accurate flow of electricity and its power source [22].

LDR (*Leight Dependent Resistor*)

Light Dependent Resistor, abbreviated as LDR, is a resistor whose resistance value or resistance value depends on the intensity of the light it receives. The LDR resistance value will decrease when the light is bright, and the resistance value will be high in dark conditions [5].

RESULTS AND DISCUSSION

Solar Panel output voltage measurement

The results of the 1-watt solar module test are shown in Table 1.

Table 1. Solar panel measurement results

Load Current	Voltage	Electric Current	Load
09.00	5.8 VDC	0,02 A	100 Ω
13.00	7.0 VDC	0,10 A	100 Ω

While in Figure 8, it shows documentation of testing a 1-watt solar panel with a digital voltmeter.

Figure 5. Measurement of the solar module with a voltmeter

Measurement Output IC TP4056 Solar Panel input.

The result of measuring the output of the ic tp4056, with input from the solar panel, dried in the Sun.

Table 2. Output measurement results of IC TP4056 with solar panel input

Testing Time	Vout	Load

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	TP4056	
09.00	2 VDC	0,02 A
13.00	4 VDC	0,10 A

Measurement Output IC TP4056 input Adapter 5VDC

The results of measuring the output of the ic tp4056, with the input of the 5VDC adapter.

Table 3. Output measurement results

Specification	Vout TP4056	Load
Adaptor 5VDC/3A	4 VDC	0,1 A
Adaptor 5VDC/2A	4 VDC	0,1 A

Figure 9 shows a comparison of wave changes when it is loaded and not loaded, the IC P4056 wave when charging the battery, and when the 3.7 VDC battery is full.

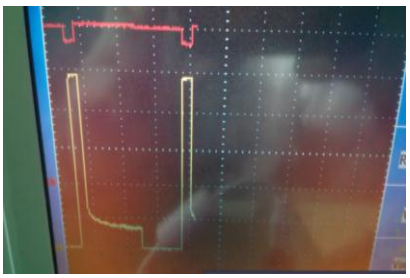

Figure 6. Wave comparison display on an oscilloscope

Measurement of the joule thief circuit output voltage and 12 Watt lamp load

The results of measuring the output of the joule thief circuit and the 12-watt lamp load.

Table 3. The results of measuring the output voltage with a load of 12 watts

Vin	Lamp load 12 watts	Load
1.5VDC	Dim	0.45mA
3.7VDC	Light	0.90mA
3.7 VDC x 2	Light up	0.90mA

Figure 7. Joule thief test with a voltage of 7.4 VDC

Testing the working time of the lamp load and the joule thief circuit

The test was carried out with a pack of 6 LEDs with a power size of 0.6 W and different battery voltages.

Table 4. Testing the working time of the load with the joule thief circuit

Voltage	Power	On-Time	Description
1.5VDC	0.5W x 6 LED	10 hour	Dim lights, hot headphones
3 VDC		10 hour	Hot headlights
7.4 VDC		8 hour	The light is very bright, and the heatsink is hot and disconnected.

Figure 8. Testing a 1.5VDC battery with 6 LEDs of 0.5W

Testing controller with LDR (Leigh dependent resistor)

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The test is conducted by reading analog data on the LDR in light or no light conditions.

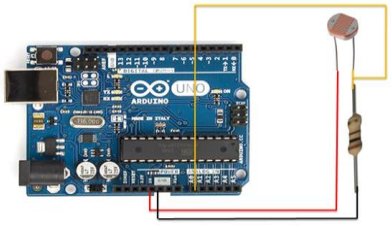

Figure 9. LDR . light intensity meter circuit

Table 5. LDR . test results

Condition	Voltage	ADC
Dark	5-12VDC	0 – 490
Dim		< 500 - 790
Light		> 800

After designing, testing, and measuring, it was found that with 7.4 VDC input from the 18650 lithium battery, it increased the voltage through a booster or joule thief circuit so that the 12 watt/220V lamp load was able to light up. In addition, through the TP4056 IC, the battery is used to supply Arduino, which also functions to drive the servo motor according to orders from the Arduino controller. The solar panel will charge the battery if the weather is cloudy with the conditions still feeling hot in the surrounding environment.

CONCLUSION

With a 1 watt solar module and two input 18650 batteries, with a voltage of 7.4VDC or equivalent to 1 A, it can power a lamp load of 12 Watt/220V. The street light will turn on when the LDR value data is in the range of 0 to 490 ADC, which means the condition is at night. In contrast, the design of the tool or lamp will turn off when the LDR range value is more than 800 to 1023, according to the datasheet provided by Arduino, as well as analyzing efficiency. The operating efficiency of the tool design is still at the input of 3.7VDC with a load of 0.5W x 6, and the working time is 10 hours. Meanwhile, the 7.4VDC information can only turn on for 8 hours, with the headset being hot and the lamp short or broken.

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