Design of power supply circuit used thin-film solar cell for drones

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Abstract. The paper proposes the design of a power supply circuit for charging drone batteries using thin-film solar cells. Thin-film solar cells are arranged in parallel to produce a fixed voltage and a large enough current to be able to charge the battery drone. Each output of the solar cell is connected with a step-up device so that the voltage rises to 5 volts. Then all the output from the step-up will be inserted into the power booster supply so that the voltage rises to 28 volts. The unique form of thin-film solar is lightweight and flexible, so the power plant will be placed right above the frame of the drone. The goal is that sunlight can be directly received by the top layer of the solar cell to be converted into voltage. The design of this power supply circuit is expected to be able to increase the length of the drone’s flight in the air.

1. Introduction
Unmanned Aerial Vehicles (UAV) is one of the technologies that can be controlled remotely [1]. One type of UAV that is widely used and developed is a drone. The use of drones covers several fields, for example in the fields of military, commercial, civil, scientific or academic fields for some intelligent applications [1,2].

Drones have several disadvantages, such as short flight times. Most commercial drones have a maximum flying time of 15 minutes [3]. This is one of the obstacles for the use of drones with a longer time. Many researchers take research on drones. Syafruddin et al. [2] has developed a power supply system for drones as battery power support so that the drones can fly longer. They use thin-film solar cell and TEG as the main power supply. As a result, the duration of flying drones in the air can increase by a few seconds. But the TEG that is used has not functioned optimally, so it does not produce a voltage (0 volts).

The non-renewable energy resources from world energy fuels are 85%. They are not only used for electricity generation but also domestic, transportation and other needs. Because they are increasingly thinning [4]. Therefore, world electricity supply needs to be reversed from 68% of fossil fuels to 65% of renewable energy sources, by 2050. This renewable energy can also be called green or clean energy because it produces fewer carbon emissions [4]. One tool or module that can produce electricity but is environmentally friendly is Photovoltaic (PV) or commonly called solar cell. Solar cell technology on the market is currently classified into three generations depending on the basic ingredients used and the level of commercial maturity. The second-generation solar cell system is based on Thin Film technology. This Thin Film solar cell is interesting to develop because of its thin, light and flexible shape [2].
This paper tries to make a design of a series of electric ratios by utilizing a 2Volt/0.5Watt thin-film flexible solar cell power generation module. This series aims to increase the number of times the drone flies while in the air. To support the output of the power plant, a step-up tool and power booster supply are added. The shape of a unique power plant is lightweight and flexible, so the circuit can be mounted on the body of the drone.

2. Thin-film solar cells
Photovoltaic or commonly called solar cell has grown rapidly by utilizing the most abundant energy source in the world, namely sunlight [5]. Solar cell technology on the market is currently classified into three generations. The first generation uses a wafer-based Crystalline Silicon (c-Si) technology. The second generation is based on thin-film technology. The third generation is the technology of Concentrating Photovoltaic (CPV) and Organic PV cells which are still in the demonstration or have not been commercialized widely [6].

Thin-film solar cells, generally made from steam deposits derived from solid semiconductor absorbent films, then flanked between selective load contacts, slowly approaching the efficiency of c-Si [5]. Thin film technology began research activities since the early 1980s [6]. They are pursuing cost-effective power generation technology to lead large companies and investors towards the thin film industry. The majority of solar cells are rigid materials that ignore flexibility. Flexible solar cells have many advantages, such as being easily transportable, unbreakable and lightweight. Many types of p-n connections on flexible substrates are created. An example is Tedlar, PET and glass with ITO as transparent front contacts that are used as substrate media and substrate [7].

3. Analysis
The paper tries to develop research that has been done by Syafruddin Syarif et al [2]. The study made a series of electric ratios utilizing a 2Volt/0.5Watt power generator module for thin-film flexible solar cell and thermoelectric generator SP1848-27145SA. The series aims to increase the number of long-time drone flights while in the air. To support the second output of the power plant, a step-up voltage tool is added. The circuit is mounted on the body of the drone by considering the weight of the circuit. The type of drone used is the F450 assembled drone for easy development.

The results of the research by Syafruddin Syarif et al [2] shows that the testing of electric power circuits produces voltage output for thin-film solar cell modules which tend to decrease in passive and active drone conditions above the air. While the thermoelectric generator module in the circuit has not been able to produce any voltage at all in the electrical circuit. The following are the results of testing the power plant module in the research of Syafruddin Syarif [2].

3.1. Testing in the morning

![Figure 1](image)

Figure 1. The output voltage of the thin-film solar cell module is passive (idle) [2]
Figure 2. The output voltage of the TEG module is passive (idle) [2]

Figure 3. The voltage output of the thin-film solar cell module is active (moving) [2]

Figure 4. The voltage output of the TEG module is active (moving) [2]
3.2. Testing during the day

Figure 5. The output voltage of the thin-film solar cell module is passive (idle) [2]

Figure 6. The output voltage of the TEG module is passive (idle) [2]

Figure 7. The voltage output of the thin-film solar cell module is active (moving) [2]
Taking into account the results of the above data, we can analyze that thin-film solar cell power plants are more optimal than TEG to be used to make a power supply circuit on a drone device. Although only uses one solar cell, but can add a few seconds to fly the drone in the air. This power plant can produce voltage even if it only catches a little sunlight. These results can be the basis for developing further research.

4. Proposed design

The results of the above research show that the circuit can be developed by redesigning the electrical circuit using only the solar cell thin-film power generation module. The type used in this circuit design proposal is 2Volt/0.5Watt thin-film flexible solar cell. The circuit also added a step-up voltage tool to meet the working voltage requirements of the drone. Thin-film power plants are solar cells arranged parallel with the addition of a step-up DC 600mA PFM control phone charging. Furthermore, each of these outputs is connected to a device, namely the MT3608 step-up 2A boost regulator DC mini XL6009 power booster supply. This series aims to increase the length of the drone's flight in the air. For more details, see figure 9:

![Figure 9. Block power supply circuit diagram](image-url)

The output voltage of each thin-film solar cell is between 0.7 - 5 Volt, so it must be connected with a step-up DC 600mA PFM control phone charging. The goal is that all the output is the same, which is changed to 5V. Then the output of each step up is coupled to the MT3608 step-up 2A boost regulator DC mini XL6009 power booster supply. The goal is that the 5 V output voltage rises to 28 V to meet...
the working voltage requirements of the drone. The 2V / 0.5W solar cell flexible thin-film used has a unique shape which is small, light and flexible. This solar cell can be curved to an angle of 30 degrees. See figure 10:

![Figure 10. 2Volt/0.5Watt solar cell flexible thin-film](image)

Furthermore, heavy thin-film solar cells and step-up voltage devices have their respective weights. The total weight of all components will be considered. The weight of the thin-film 2Volt/0.5Watt flexible solar cell is 100 grams. Then the weight of the step-up DC 600mA PFM control phone charging is 14 grams and the MT3608 step-up 2A boost regulator DC mini XL6009 power booster supply is 10 grams. So it is very possible that this power supply circuit is installed in the body of the drone.

Total thin-film solar cells installed adjust the number of drone skeletons in general in the form of x (cross) or + (plus) that is 4 pieces. Each thin-film solar cell is installed just above the frame of the drone. For more detail see figure 11:

![Figure 11. Sketch of thin-film solar cell installations on drones](image)

The purpose of thin-film solar cell mounted on a frame is that sunlight can be directly received by the top layer of the solar cell to be converted into voltage. The power plant is arranged in parallel with the aim that the circuit can produce a fixed voltage and current large enough to be able to fill the battery drone.

5. Conclusion
The 2V / 0.5W solar cell flexible thin-film has a lightweight and flexible form so it is very easy to use for many devices. This paper proposes the design of a power supply circuit using the solar cell which is arranged in parallel with the aim that the resulting current is large enough to be able to fill the battery drone. The solar cell is placed right above the frame so that it can directly capture sunlight. The design of this series is expected to increase the duration of flight of the drone in the air compared to previous studies.

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