GREEN CHARGER WITH UV DETECTOR

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ABSTRACT

The main feature of this project is that it contain a two solar panels that will utilize light energy to produce electrical energy. It will be designed and built to have multiple purposes based on the power output from the solar cell panel. This project will consist of 2 main functionalities that will be implemented in the order that they are described. The first purpose of this project is to be able to charge a phone with the electricity generated from the solar cell. The second functionality of our project includes a UV detector. We used a UV sensor as our UV detector, which outputs an analog signal in relation to the amount of UV light that's detected. Using the ADC on the controller, then convert the analog signal to a digital input which will tell us how much UV light is present. Based on the information provided in the datasheet of the UV sensor, the analog voltage can be directly converted into UV index. Based on this information, we can display a warning to the user to inform him/her that there is too much UV light present. The device GREEN CHARGER a product that can solve all of those problems and provide an environmentally friendly alternative to traditional portable chargers.

Keywords: Green charger, mobile, Solar panel, UV detector, ADC and controller.

I. INTRODUCTION

The primary idea of the project comes from the group discussion who are interest in green energy. Weather variation is a widely discussed topic and there has been much debate on how humans should try to mitigate the influence of climate change. Then, we would like to create a sustainable product that uses clean energy and helps to reduce the usage of non-renewable and pollute energy sources such as fossil fuels. Then, we decided to build a portable solar cell phone charger to utilize sustainable and renewable solar energy [1].

II. HARDWARE DETAILS

The hardware of the Green Charger with uv detector is consists mainly of a microcontroller,

1. Solar panels
2. Buck converters
3. U V Detector
4. Microcontroller

The complete green charger with UV detector block diagram is shown in below figure 1.
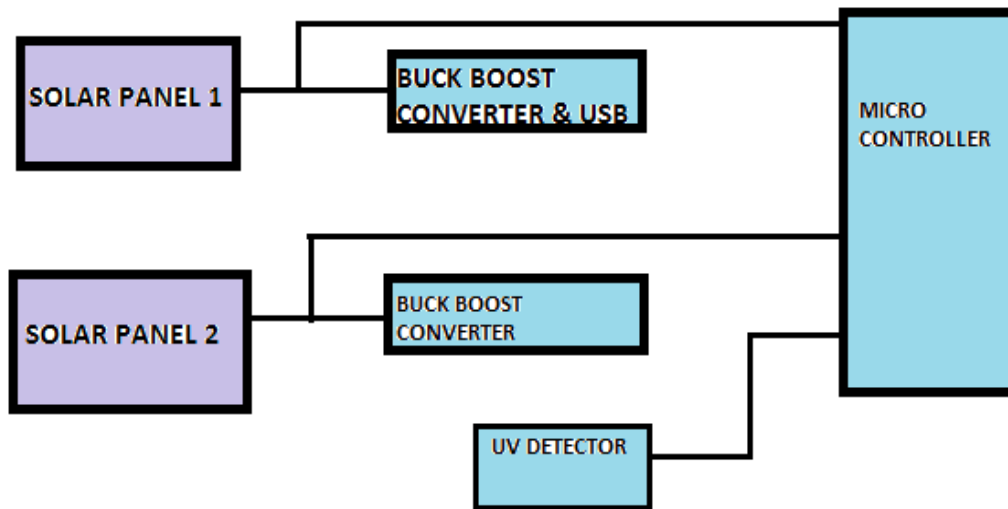
Figure 1: Block diagram of Green charger with UV detector

A. Solar panel

Our starting point for all our hardware decisions was based on what types of photovoltaics we would use. After some research, we found that PV cells with a high current would be fairly costly. Since we did not have a large enough budget to spend upwards of 40 or 50 dollars on a high power (wattage) solar cell, we opted for a cheaper one that would meet the voltage specifications while only sourcing low amounts of current. This is most problematic for the phone charger itself, as phones charge more quickly when more current is supplied. However, as long as the voltage specification is met, the phone will charge. As for the MCU, we roughly estimated that in steady state it would draw no more than ~200 mA of current, and this was a rough estimate. Nevertheless, we picked components that could supply it much more [2].

We used the two 2.5W 5V 500mA ALLPOWERS solar panels. They were sized 130x150 mm, so they were neither too big nor too small for the project. After doing some research on the part, we learned that the OC voltage could be as high as 8.2V, and on sunny days the voltage (with a load circuit) could still go as high as 6V. In addition, the current almost never actually reached 500 mA. More often than not, it would stay around 200-300mA on sunny days. This prompted us to look for a buck converter that could step down the voltage to a safe 5V value for our USB connection and for another buck converter that could safely step it down to 3.3V for our MCU.

This state display the voltages of both solar cell panels and the user can access this state to read the voltages provided by each solar panel by pressing 3 once in main menu. As described in the MCU voltage state and the USB charging state, we configured the same ADC pins (ADC pin 7 and ADC pin 26) to measure the voltage that is supplied by the solar panels. This was relatively straightforward as we just had to reuse the connections and equations that we had used in the USB charging state and the MCU voltage state.

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B. Buck/Boost Converter

The buck/boost converter specifies an input voltage of 3V to 12V, an output voltage of 5V, and a current of up to 500 mA in boost mode, and up to 1000 mA current in buck mode. For reference, most USB phone chargers will supply 500 mA at 5V (2.5W). With USB 3.0, this has been increased to 900 mA, and dedicated USB charging ports can go as high as 1500 mA. Wall chargers that are provided when purchasing phones can go even higher; Avi's motorola charger provides up to 2.85 A. However, these high current values were infeasible for this project, and were even higher than what a user would experience when plugging in their phone to their laptop or personal computer to charge. With these details in mind, we initially decided to connect the solar panels in parallel, and load the regulated +5V line with both the MCU (after connecting it to the LDO) and the phone charger. However, when tested, the phone charger sunk all of the current, causing the MCU to shut down. Since we did not have any fancy current control mechanisms, we simply decided to isolate the two circuits of the solar panels [3].

C. UVdetector

This state measures the current UV index and the user can access this state to read the current UV index and take actions accordingly by pressing 4 once in main menu. Advice is also provided for the user to determine what is the correct course of action to take and the course of action depends on the amount of UV light detected by the Analog UV Light Sensor Breakout - GUVA-S12SD. An additional ADC pin (pin 26) has been configured on the MCU to measure the voltage output from the UV detector. The sensor is powered with 3.3V by the MCU and it shares the same ground as the MCU.

In this case, the voltage reference we are using is 3.3V. No voltage divider was used for the output voltage, thus there is no multiplication factor of 2 in this equation because the output voltage from the UV detector is expected to be much lower than 3.3V. If the output voltage from the UV detector is 1V, then the UV index is approximately 10. Given that the highest recorded UV index in the history of mankind is 26, we can see that the output voltage from the UV detector could theoretically only meet a maximum of approximately 2.6V. The equation for the UV index was obtained from the datasheet.

D. Microcontroller

In this case, the voltage reference we are using is 3.3V since the ADC is only able to measure up to 3.3V. It is also important to note that we have a multiplication factor of 2 in our equation. This is because we are using a voltage divider circuit which consists of two 10K ohm resistors. Since the voltage could go as high as 6V under sunlight, it was necessary to use two 10K resistors to halve the voltage down. Then, in our code, we multiplied the value by 2 to get the correct reading of the voltage supplied to the MCU.

We have organized the various states for the solar cellphone charger in a finite state machine. Upon entering the charger, we have a state 0 where a welcome message is printed. The next state is the main menu where all the states are listed and the way to get to each state is also specified. Thus, according to the specification, the user can press the corresponding keys to go to the desired states.

We also decided to include a pictorial representation of the voltage being supplied to the MCU. This is shown in the form of a progress bar, which increases in length as more voltage is being supplied to the phone. The implementation of the progress bar is explained in greater detail in the USB charging state.The detailed states going from the main menu and their functionalities are listed below.

III. RESULTS

The overall execution speed was very fast since in software we only had two simultaneous threads. One thread is used to kept track of which key is pressed and the other thread allows the user to switch between various states and check the proper functionality and result accuracy of each state. Depending on the intensity of the sunlight, the amount of current supplied to the phone will vary. Since there are many hardware implementations in this project, in each step of the hardware design, we double checked our calculations and designs to ensure the circuit would work as anticipated and wouldn't overload any hardware components. The final product of this project exhibits high levels of usability. The user can just connect their phone to the USB port, put the whole setup directly under the sun on a sunny day, and the Green Charger will automatically charge the cell phone.

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