

SOLAR BEACH CHAIR

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Project No. 2

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1. Introduction

1.1 Project Overview

Title: Solar Beach Chair

Cell phones and electronic devices have become a given in every aspect of people's lives. Today, no one goes anywhere without their electronic devices and everyone dreads that moment when the battery icon turns red. Luckily, this country has adapted and power is available pretty much anywhere. When a device is reaching the end of its battery, it is highly likely that there is a power outlet within reach whether it is on the wall, in a computer, or even in your car. However, there are still some places that do not offer the convenience of on-site power, specifically the beach. As a group of avid beach goers, when our phones, tablets, or e-readers die we would love to be able to charge them without having to bring an end to our beach day.

Since sun is synonymous with the beach, it would make sense to convert that energy from the sun and use it to charge devices. What we want to do is convert an object you would bring to the beach anyway into a charging station for your electronic devices. We are excited to take an ordinary beach chair and convert it into a product that is sure to revolutionize beach going.

1.2 Objectives

1.2.1 Goals

The goal of this project is to design and build a beach chair that allows the user to safely and conveniently charge their USB devices while they are away from electric outlets. We plan to do this by converting the energy from the sun to USB ports located on a canopy beach chair that is durable and portable.

1.2.2 Benefits and Features

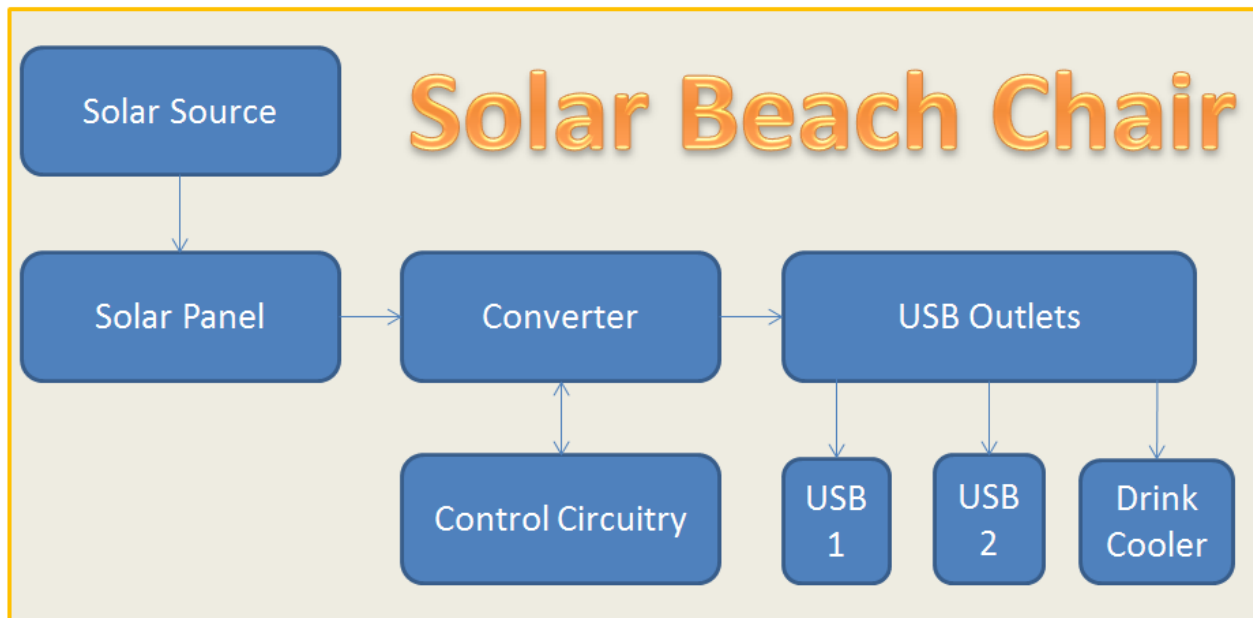
- Charge devices while soaking up the sun
- Solar canopy provides the user with shade
- Backpackable for easy transport
- Built-in electric drink cooler
- Environmentally friendly

- Weatherproof, sandproof, and durable

Overall, this product will be of great convenience and novelty. Battery life will no longer be a factor in deciding whether you want to work on a tan or catch up on the latest news. Long gone will be those days that you have to go home early because you need to charge your cellphone.

2. Design

2.1. Block Diagram



2.2. Block Descriptions

2.2.1. Solar Source

For the final design, the solar source will be the sun. For design and testing purposes in the lab, lamps will be used. The testing solar source will have to have variable light levels in order to mimic the sun. Having solar as a source of energy is what makes this product environmentally friendly.

2.2.2. Solar Panel

A solar panel of sufficient power capacity will be mounted on the beach chair. For our advertised features, two USB ports and a drink cooler, we anticipate needing a maximum of 26 Watts for the maximum load (two tablets and the cooler). Due to

efficiency and the variability of the sun, we want a panel in the 40-50 W range. On top of harnessing the sun's energy, panel will also act as a shading element for the user. The panel will have to be light so that the chair is easily portable and it also must be durable because it will be in the beach environment where salt water and sand will be an issue.

2.2.3. Converter

The converter circuit will take the power from the solar panel and convert it so that it can be delivered to the devices through USB. Based on the data we collect from our solar panel, the converter will have to take whatever input voltage the panel outputs and convert it to a 5 V output for charging. It will have to have three outputs, one for each of the two USB charging plugs and one to drive the drink cooler.

2.2.3. Control Circuitry

The control circuit will be designed to regulate the converter so that it consistently outputs the desired voltage and power.

2.2.4. USB Ports

The converted energy will have to be fed to the devices through a USB port. This port will be integrated into the arm of the chair for convenient charging.

2.2.5. Drink Cooler

The drink cooler will be designed such that it consists of a cup/cup holder combination that keeps your drink cool in the hot sun. The cooler will be of our own design and will consist of a cup/cup holder combination that keeps your drink cool in the hot sun.

2.2.6. Beach Chair

We have chosen to use the Kelsys Wave Beach Canopy Chair. The final project will consist of all the components assembled onto the beach chair. The solar panel will be mounted onto the canopy. The converter will be weather proofed and neatly integrated onto the chair so that the output for the devices can come out of

the arm rests. The chair will also be adapted to support the extra weight of the panel if needed and be made into a backpack for easier transport.

3. Requirements and Verifications

3.1. Requirements

1. The converter must be able to take the voltage from the solar panel and step it down so that a 5 V \pm 5% (4.75-5.25 V) output is created.
2. The controller needs to regulate the duty cycle of the converter based on the input and output voltage so that the output voltage stays at 5 V.
3. The USB port needs to fit a universal USB cord and also needs to be able to stay safe from sand.
4. The drink cooler should run off 5 V and keep a drink cooled to 45 degrees Fahrenheit.
5. The chair must be structurally sound enough to support the panel, light enough to be carried, and have weatherproofing aspects to protect the equipment mounted on it.

3.2. Verification

1. The operation of the converter can be verified using the lab in 50 Everitt. A voltage source will be hooked up to the circuit. The duty cycle will be controlled by hand and a wattmeter will be used to confirm the output voltage is 5 V. The oscilloscope will be used to verify that the ripple is within specification.
2. The controller operation will be verified by showing that it sends the proper signals based off the output voltage that it reads.
3. To verify the USB port, a physical demonstration will be used to show that the port is universal. Also, it will be shown that there is an implementation that keeps sand out while a device is not plugged in.
4. The drink cooler will be verified by placing a drink in it and confirming that it can reach the advertised temperature.
5. A physical demonstration will be used to show that the beach chair can support the panel while still being foldable and easily carried. Reasonable water and sand tests will be done to confirm that the product is protected from the elements.

3.3. Tolerance Analysis

The most important part of our design will be our converter. In order to ensure that the chair will function to its maximum capacity load, the efficiency on the converter will have to be high. We are aiming for 80% efficient or better. For low power outputs, this should not be too hard but as the output power is increased, this will become more difficult.

4. Cost and Schedule

4.1. Cost Analysis

4.1.1. Labor:

Name	Hourly Rate	Number of Weeks	Hours Per Week	Total Hours	Total = Hourly Rate x 2.5 x Total Hours
Damen Toomey	\$30.00	12	12	144	\$10,800
Andrew Gazdziak	\$30.00	12	12	144	\$10,800
Emily Mazzola	\$30.00	12	12	144	\$10,800
Total	\$90.00	36	36	432	\$32,400

4.1.2. Parts:

Item	Quantity	Unit Price	Total Cost
Canopy Beach Chair	1	\$46.88	\$46.88
Solar Panel (≈ 50 W)	1	\$151.00	\$151.00
Drink Cooler Base	1	\$34.95	\$34.95
USB Protective Jacks	10	\$0.65	\$6.49
USB Ports	3	\$6.99	\$20.97
USB Extension Cord	3	\$4.99	\$14.97
Backpack Strap	1	\$14.99	\$14.99
Waterproof Casing	1	\$1.75	\$1.75
Op Amps	6	\$0.25	\$1.50
Resistors	20	\$0.05	\$1.00
Capacitors	2	\$0.10	\$0.20
Inductors	1	\$1.00	\$1.00
Schottky Power Diode	1	\$1.20	\$1.20
MOSFET	1	\$3.95	\$3.95
PCB	2	\$50.00	\$100.00
Total Cost			\$402.05

4.1.3. Grand Total

Labor	Parts	Grand Total
\$32,400	\$402.05	\$32,802.05

4.2. Schedule

Weeks	Damen	Emily	Andrew
2/4/2013	<ul style="list-style-type: none"> • Purchase Solar Panel • Create Detailed Converter Design 	<ul style="list-style-type: none"> • Purchase Beach Chair • Finalize and hand in proposal 	<ul style="list-style-type: none"> • Sign-Up for Mock Review • Create Detailed Control Design
2/11/2013	<ul style="list-style-type: none"> • Implement Buck Converter with FET Box 	<ul style="list-style-type: none"> • Gather Solar Panel Statistics 	<ul style="list-style-type: none"> • Implement Control Circuit
2/18/2013	<ul style="list-style-type: none"> • Prepare for Design Reviews • Sign-Up For Design Review • Learn the Eagle CAD Software 	<ul style="list-style-type: none"> • Prepare for Design Reviews • Optimize the Design For Highest Efficiency 	<ul style="list-style-type: none"> • Prepare for Design Review • Work with Machine Shop and Electronics Shop
2/25/2013	<ul style="list-style-type: none"> • Create PCB 	<ul style="list-style-type: none"> • Edit PCB 	<ul style="list-style-type: none"> • Finalize PCB
3/4/2013	<ul style="list-style-type: none"> • Integrate Solar Panel Into Chair 	<ul style="list-style-type: none"> • Designing a Weather Resistant Enclosure 	<ul style="list-style-type: none"> • Obtain Finalized PCB
3/11/2013	<ul style="list-style-type: none"> • Individual Progress Report • Prepare For Mock Demo • Integrate Panel To Converter 	<ul style="list-style-type: none"> • Individual Progress Report • Prepare For Mock Demo • Integrate USB and Weatherproofing 	<ul style="list-style-type: none"> • Individual Progress Report • Prepare For Mock Demo • Integrate Control Circuitry
3/18/2013	<ul style="list-style-type: none"> • Spring Break • Complete Slides for Presentations 	<ul style="list-style-type: none"> • Spring Break • Complete Slides for Presentations 	<ul style="list-style-type: none"> • Spring Break • Complete Slides for Presentations
3/25/2013	<ul style="list-style-type: none"> • Mock Demo • Finalize Mock Presentation 	<ul style="list-style-type: none"> • Mock Demo • Sign-Up for Mock Presentation 	<ul style="list-style-type: none"> • Mock Demo • Edit and Review Mock Presentation
4/1/2013	<ul style="list-style-type: none"> • Mock Presentations • Confirm No New PCB is Needed 	<ul style="list-style-type: none"> • Mock Presentations • Submit PCB Request for Converter (if needed) 	<ul style="list-style-type: none"> • Mock Presentations • Submit PCB Request for Control (if needed)

Weeks	Damen	Emily	Andrew
4/8/2013	<ul style="list-style-type: none"> • Debug • Confirm all parts work individually 	<ul style="list-style-type: none"> • Debug • Confirm all parts integrate 	<ul style="list-style-type: none"> • Debug • Confirm weather and quantitative specifications were met
4/15/2013	<ul style="list-style-type: none"> • Complete Final Paper • Prepare Converter for Demo 	<ul style="list-style-type: none"> • Complete Final Paper • Prepare Drink Cooler and Chair For Demo 	<ul style="list-style-type: none"> • Complete Final Paper • Sign-Up for Demo • Prepare Control for Demo
4/22/2013	<ul style="list-style-type: none"> • Demos and Presentations • Finalize Final Presentation and Lab Notebook 	<ul style="list-style-type: none"> • Demos and Presentations • Finalize Final Paper and Lab Notebook 	<ul style="list-style-type: none"> • Demos and Presentations • Review and Submit Final Paper
4/29/2013	<ul style="list-style-type: none"> • Checkout • Confirm the final paper was submitted 	<ul style="list-style-type: none"> • Checkout • Confirm the final paper was submitted 	<ul style="list-style-type: none"> • Checkout • Confirm the final paper was submitted