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October 12, 2011

Professor Mike Sjoerdsma
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 305 Functional Specifications for the Solar Panel Cubic Charger Accessory

Dear Professor Sjoerdsma:

The document for describing the functional specification for Solar Panel Cubic Charger is attached. We are renovating the current charger currently out in the market to becoming a more convenient accessory. The charger will provide the charging function outside buildings to take away frustration when one has forgotten to charge beforehand.

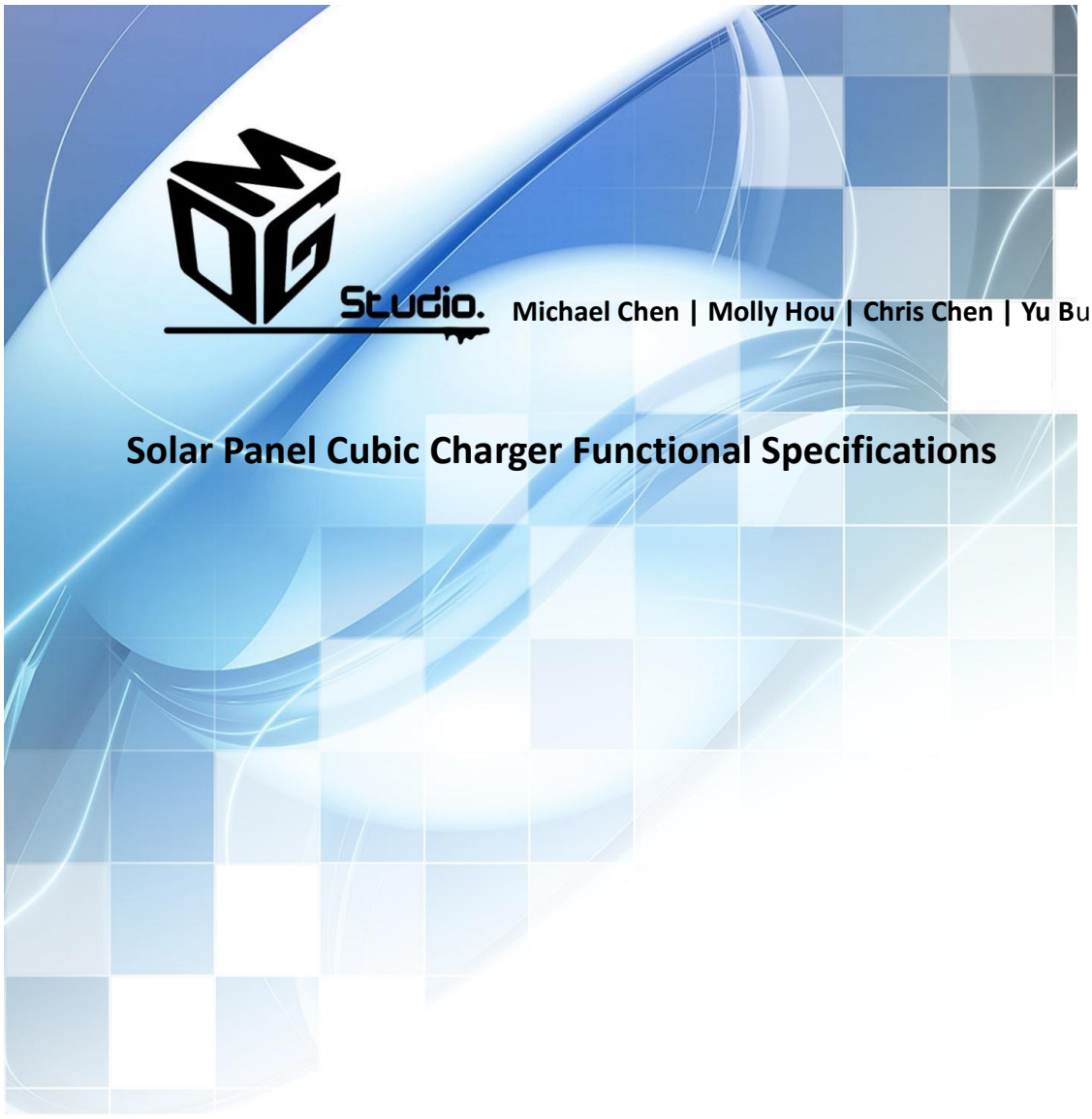
Each phase of development and concept ideas will be covered in details within this document. This will be a guideline for our engineers and project manager to follow. Further research and results will be briefly touched upon.

OMG Studio consists of four ambitious and innovated third-year engineering students: Michael Chen, Molly Hou, Chris Chen, and Yu Bu. If you have any question or concern about the proposal, please contact me by phone at (604)780-9199 or by e-mail at mpc8@sfu.ca.

Sincerely,

Michael Chen
Chief Executive Officer
OMG Studio

Enclosure: *Functional Specifications for Solar Panel Cubic Charger Accessory*



Michael Chen | Molly Hou | Chris Chen | Yu Bu

Solar Panel Cubic Charger Functional Specifications

Contact Person: Michael Chen

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Submitted to: Professor Mike Sjoerdsma

School of Engineering Science

Simon Fraser University

Submitted Date: October 13, 2011

Executive Summary

In the modern society, majority of the people will have a cell phone or an electronic device by them at all times. Whether they are playing or working with the device, battery level is always a concern. Hours of usage will cause the battery to be completely drained out in no time. Although some people have been purchasing backup batteries, it is often found dead when it is needed. Back up batteries will only last a few days after being fully charged, meaning that even if you do carry a fully charged battery with you, when you actually do need it, you will still end up with another close to drained out battery. The Solar Panel Cubic Charge intends to give the user more flexibility in charging their mobile device. As soon as the charger is plugged in, charging automatically begins by taking in solar energy.

There are two phases upon development of the Solar Panel Cubic Charger. First phase will allow the user to charge their mobile device. The charging voltage will be chosen to accommodate majority of the electronic devices for the wider range of use. The Interface will be user-friendly, designed for all ages. The development cycle of this prototype phase should be completed by end of October, 2011.

For the second phase of the development, the Charger will be implemented with a 7-segment LED display showing the current temperature and a LED to show the built-in battery's battery level. With the two additional features included, it will provide the user with some useful information about the current temperature. Most importantly, it will allow the user to have a sense for how much battery it can be used to charge their device when there is no light. The targeted completion time for second phase is end of November, 2011.

Table of Contents

Glossary

LED - Light-Emitting Diode

USB - Universal Serial Bus

Introduction

The solar panel charger is a charger that will be used to charge mobile accessories under light source. Taking in the light source for the built-in battery will allow the user to charge their mobile device much faster compared to the current solar charger out in the market. The 7-segment LED display implemented on the cube will show the current battery level of the built-in battery and the current temperature. All the functions will be described in detail throughout this functional specification proposal.

1.1 Scope

Functional requirements will be explained in detail throughout the proposal. Concept ideas and technical production guideline will be touched upon. This same list will be used as reference for the design engineers.

1.2 Intended Audience

The functional specification is intended for all member of OMG Studio. Project manager will use this document to measure accuracy of the developed result compared to the proposed product. Test engineers will cover all mentioned test cases for reliability purpose. Designing Engineers will follow the guideline for casing, user interface and internal circuitry.

System Overview

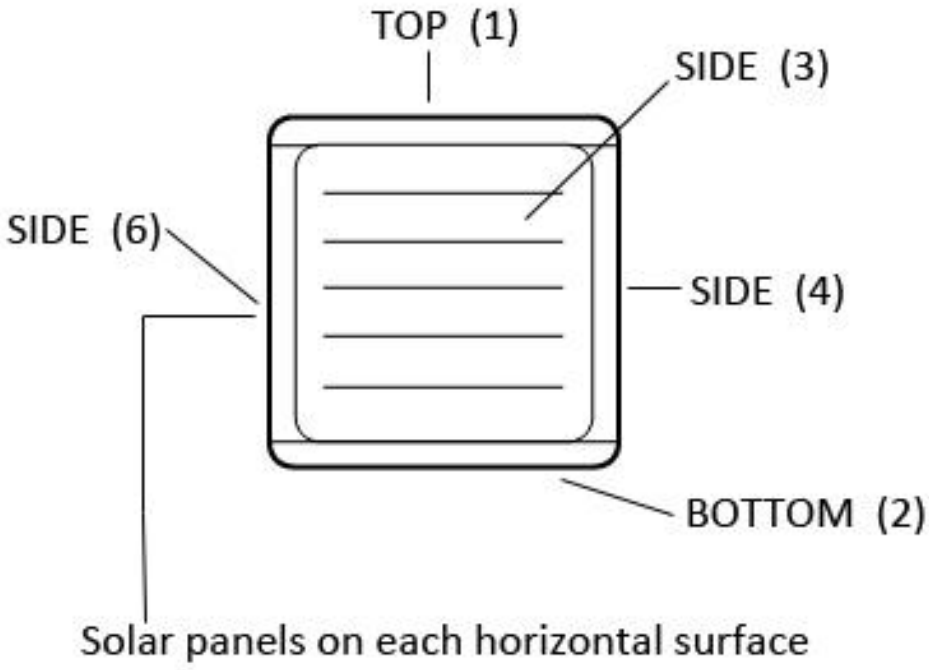

Figure 1 Side view of the complete product

Face (1): Display interface shown in Figure 2.

Face (2): Connection interface and thermal sensor shown in Figure 3.

Face (3) ~ (6): Solar Panels

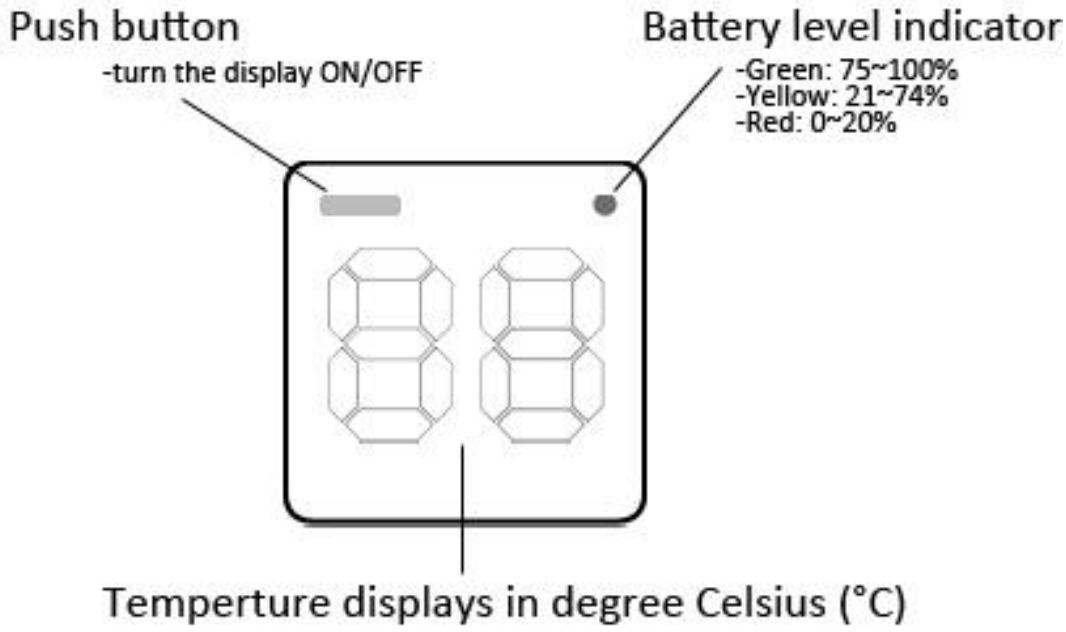

Figure 2 Top view of the complete product

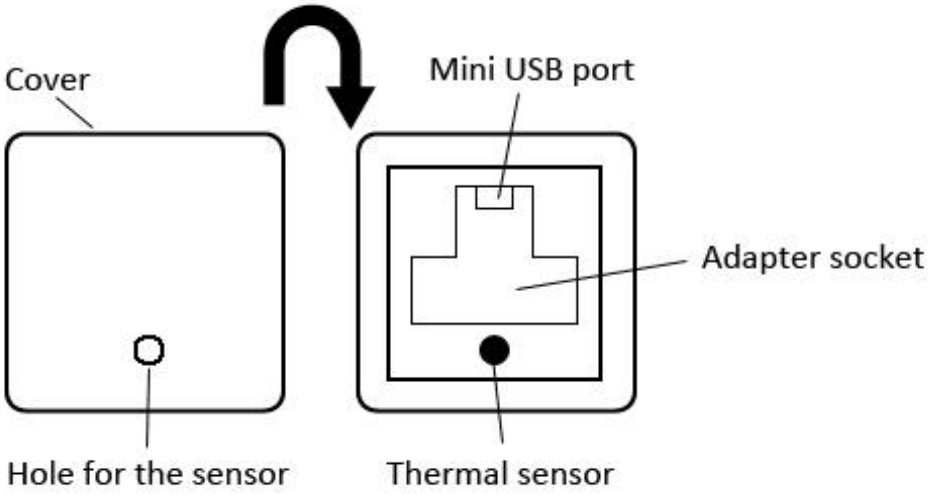

Figure 3 Bottom view of the complete product

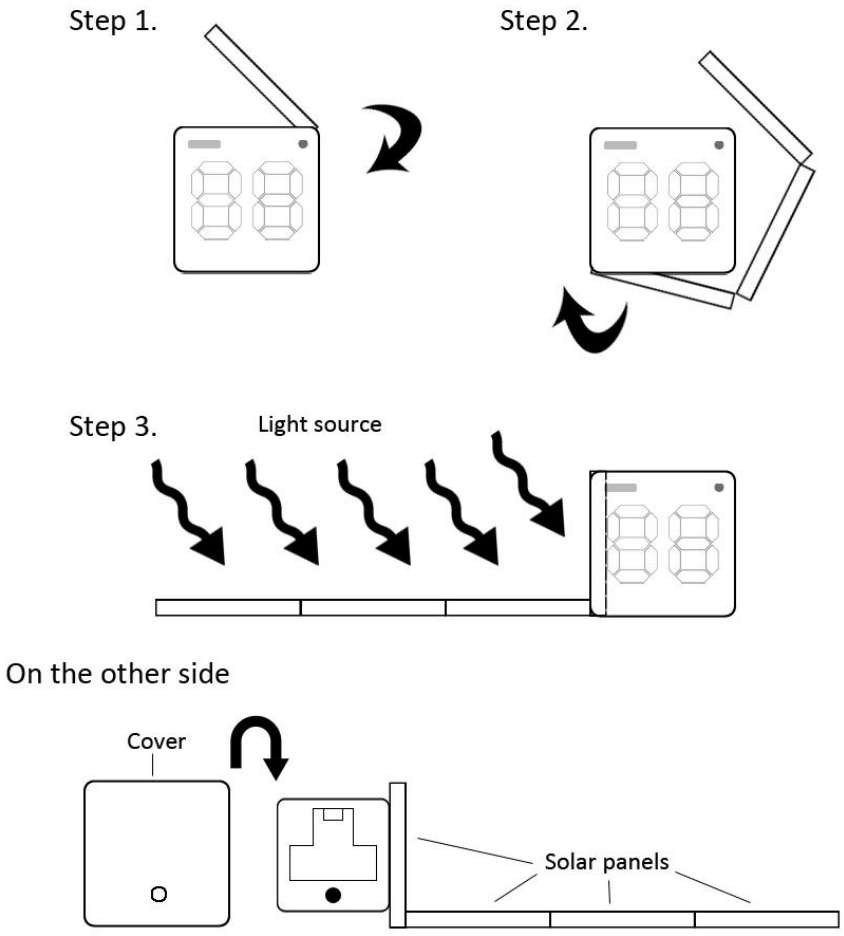

Figure 4 Expanding the complete product

Our product can be expanded like Figure 4 in order to maximize surface area for the solar panel. Maximizing the surface area will increase charging efficiency.

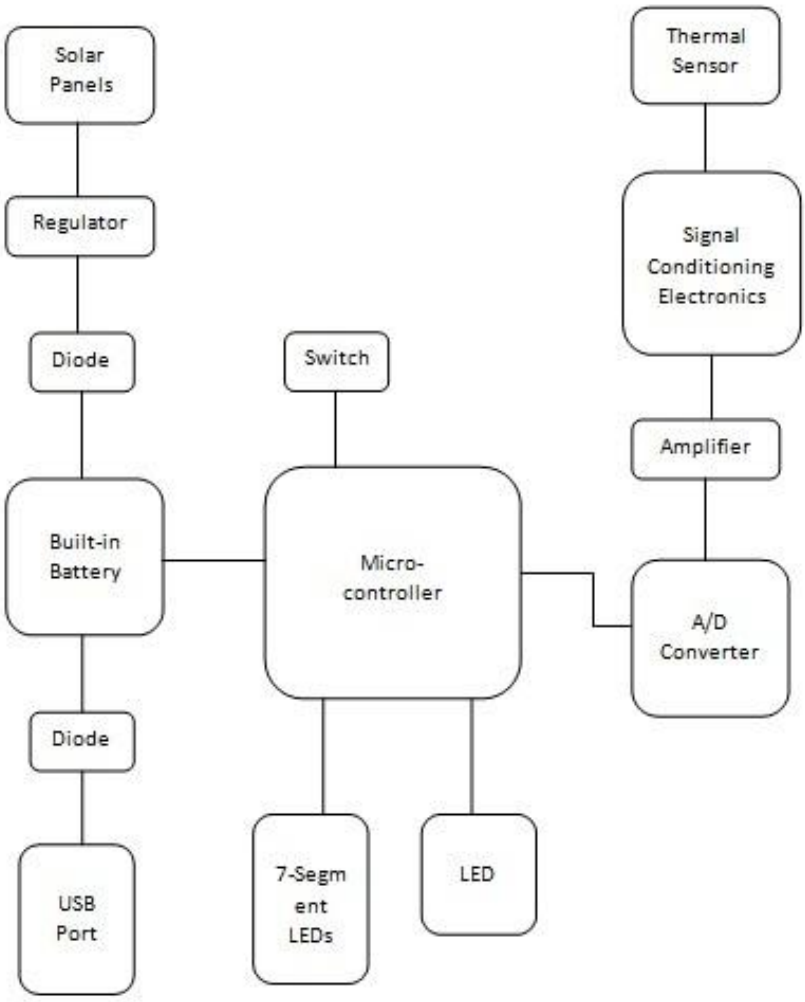

Figure 5 Block Diagram of the System Overview

Size

The general size for our product is approximately 5x5x5 cm. The solar panel itself is 4 by 4 but casing the solar panel will require a bit more space.

Packaging

The product will be retailed on the market in refined cardboard packaging. It will be decorated with our actual product's image so the consumer will know exactly what to expect. Overview of the product's function will also be briefly explained on the back of the packaging. The box will be stuffed with foam to keep the product protected.

Safety Features

- Voltage regulator:
  - Using the voltage regulator will keep the delivered voltage constant. Without voltage concern, the consumer will feel much safer when charging mobile devices.
- Waterproof
  - It will not shock the user because of electrical leakage when the device is wet
- Round corner
  - Having a round corner allows consumer of all ages to handle this product.

Reliability

- No wires between USB port and the charger port:
  - Our product should support 90% of the connections. Adapter below shows two connection examples:
- Mini-USB type A to Mini-USB type B
- Apple Dock connector to mini-USB type A

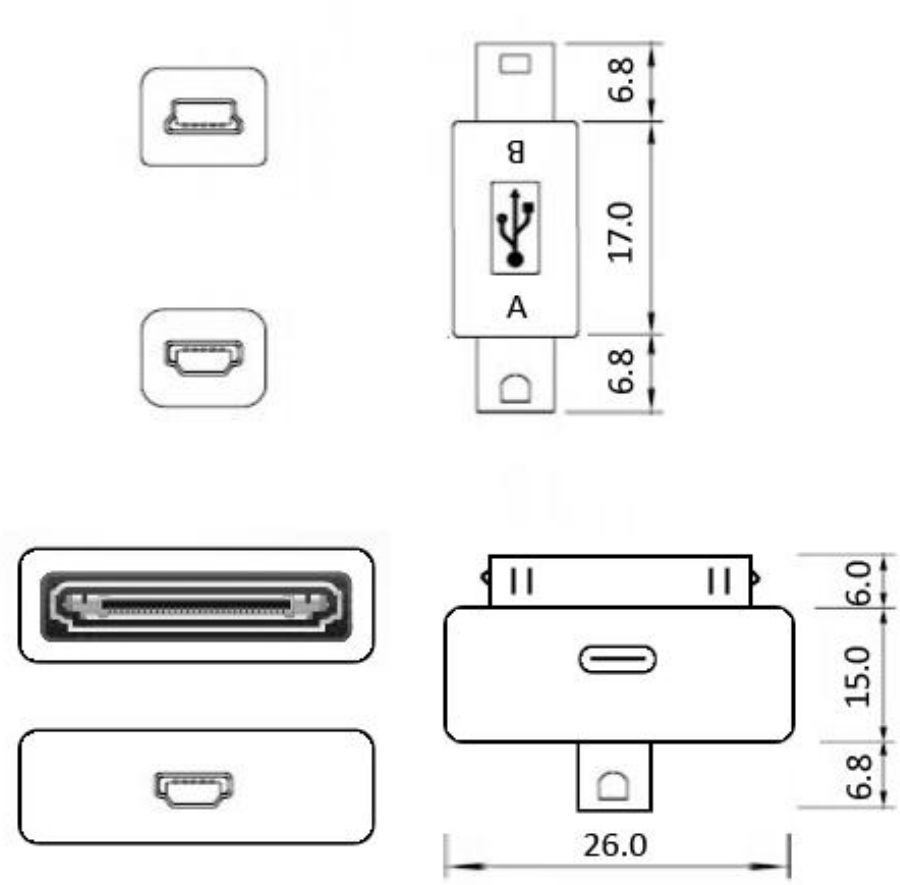

Figure 6 Connection Adapters

Due to no wiring between the two ports, chances of disconnection will greatly be reduced. When the connection is reliable, chances for the whole system to break down will be decreased.

- Stable charging:
  - Since the energy absorbed by the solar panel has a wide range due to different weather, charging the absorbed energy directly to the device may cause damage to the device's battery. Our product eliminates this problem by implementing a built-in battery. The output voltage is stable because the energy absorbed by the solar panel goes into the built-in battery first.

Through the built-in battery, it will charge various devices.

- Waterproof
    - Our product mainly operates by a connection of circuits, wires and other electronic components. As we all know, water kills electronics. Therefore, our charger is designed to be waterproof. The exterior is completely sealed off to prevent water seeping into the center of the cube since it contains the circuitry of the system. Exterior casing will be a transparent cover for the solar panel so it is exposed to the sun light.

Limitation

- The voltage is limited under 5 Volts. Our product will only charge small electronic devices, such as Play Station Portable (PSP), MP3, and cell phones. Devices like laptops will not work with our charger
- Our product is also limited by the weather, since it requires solar energy. For sunny days, the solar panel works more efficiently. Stronger lights make the charging time shorter due to more power generated by the solar panels.
- Since we are using solar energy as our product's power supply, there is a time limitation for the charging time. It will take longer to charge in comparison to charges that are connected to the power outlet.
- Solar panel's efficiency also limits our product because solar energy is our product's only energy source. A more efficient solar panel costs more than a normal one. The maximum efficiency for a solar panel is only 21%. For marketing and future reference, we decided not to use the best solar panel in the market since it will increase our cost, hence reduce our market size.
- Our product has another function – temperature sensing. We designed the product with two 7-segment LED displays. With the display, the user will be given the current temperature ranging from 0℃ ~ 99℃.

Internal

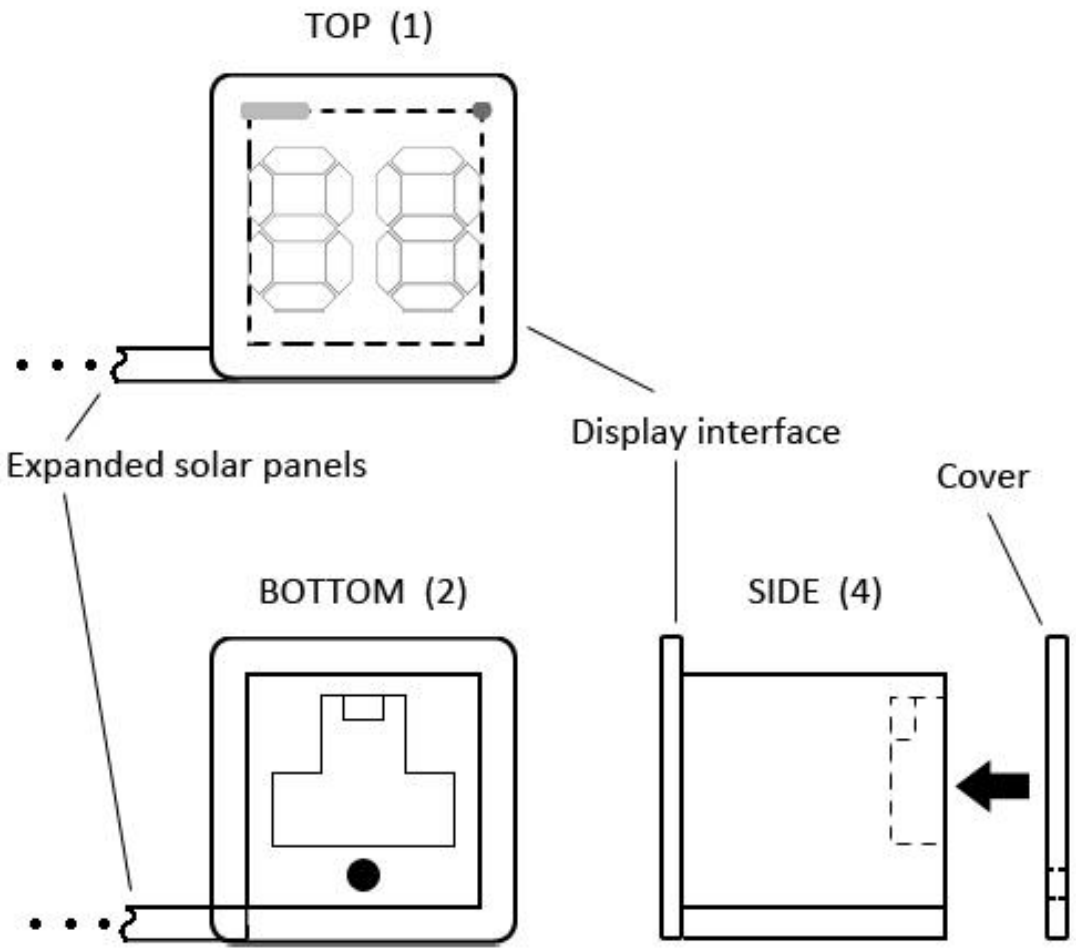

Figure 7 Internal Image of the complete product

Size

The internal volume of the cube that contains the circuit has a dimension of 4x4x4.5 cm.

Safety Features

- Cube Structure
    - The internal cube is completely sealed. Rusting of metal from oxidation will not occur. Isolating the inner circuitry from the environment will allow the product to be longer lasting.
- Voltage Regulator
    - The voltage is controlled at 5V due to the voltage regulator. It will provide the user with a safe charging mechanism as majority of the batteries used for mobile devices takes in 5V.
- Hard Casing
    - Internal cube circuitry is covered by hard material to keep the core protected from pressure.
- Consistent current flow direction
    - A diode is installed between the built-in battery and the solar panel to keep the current flow in one direction in case the built-in battery tries to flow backward. Another location to place the diode is at the output. Placing the diode at the output will keep the current flowing from the built-in battery to the mobile device instead of the other way around.

Reliability

- The reliability comes from the product being completely sealed off. Not only is the quality used inspected and refined, it will be chosen carefully.
- Built-in battery used will be a respected brand. Using a well known brand battery will keep the battery life longer.

Limitation

- Spacing is a problem to work with. Our circuit will have to be really small while working with numerous components.

External

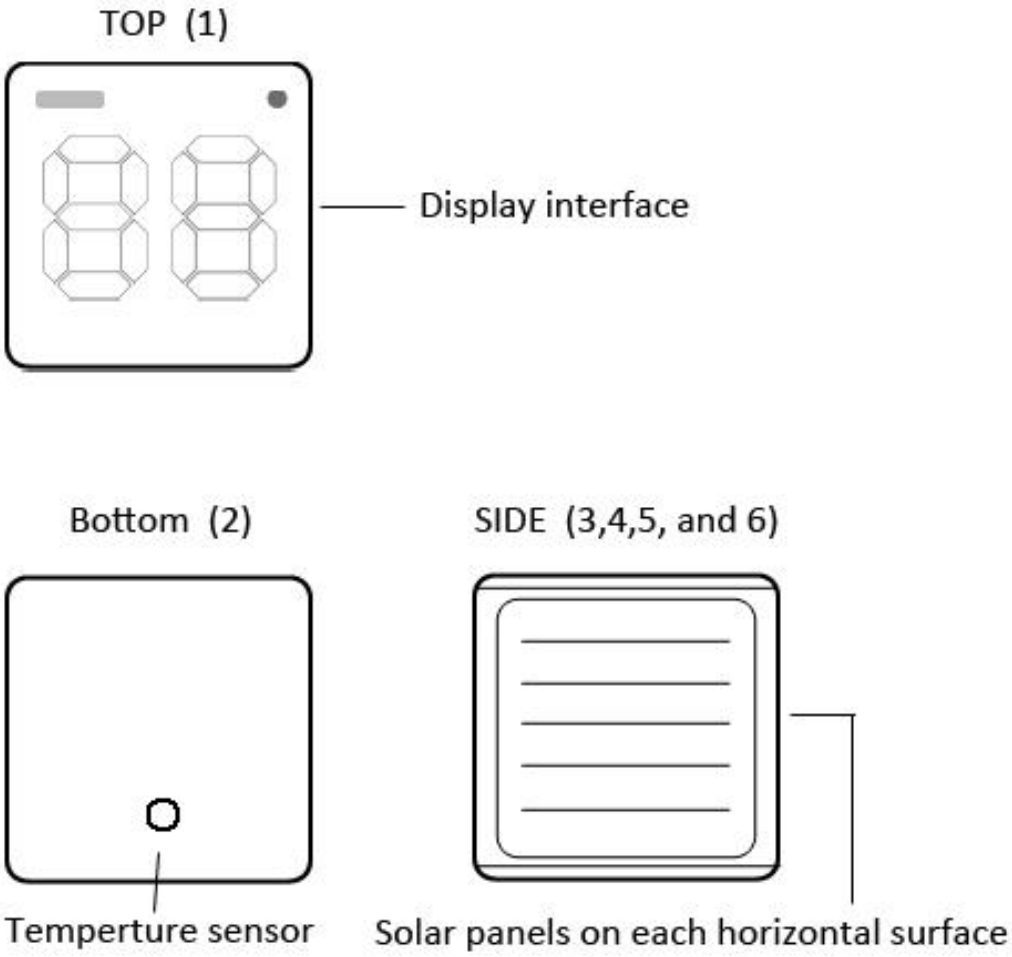

Figure 8 External Image of the complete product

Size:

The external dimension for the cube is 5x5x5 cm.

Safety Features

- Round corner
    - Round corner prevents injuries when product is being used.

Reliability

- Casing Structure
    - The inner face of the exterior is covered with rubber. The rubber acts as a connector for the casing to be held together. Connection between each face will not break due to too much shaking or too much bending since it is very stretchable.
- Hard Surface
    - Choosing the proper material for the external cover will maximize protection. With a solid casing, reliability of the product will greatly increase since it will not break easily.

Limitation

- Solar Panel
    - The standing surface after expanding the product is a major limitation. Solar energy is not being taken in at its maximum potential when it is not facing the light source directly.
- Heat
    - Sitting the cube under the sun light for a while will heat up the surface. Choosing the casing material carefully will resolve this problem significantly.

User interface

- **ON/OFF Switch**
  - Enables the LED display when it is switched ON
  - Disables the LED display when it is switched OFF
- **LED Display**
  - Displays the temperature when the product is switched on
  - Displays the battery level of the built-in battery when the product is switched on
  - Will not display any information when the product is switched OFF
- **Segment Lock**
  - Locks each segment of the surface when placed in its original packaging location
  - Lock is mechanically designed with no need of electrical power
- **Changeable adapter**
  - The connection port can be changed according to users need.

Test plan

Testing the product consists of various stages for each component.

Solar Panel + built-in Battery:

Sunny weather testing stage for solar panel and built-in battery:

- Test for charging
  - See whether the battery is constantly being charged under sunny weather
- Charging speed
- How much was charged into the battery after 30 minutes
  - Ideally, a 5V battery should be full within 3 hours

Cloudy weather testing stage for solar panel and built-in battery:

- Test for charging
  - See whether the battery is constantly being charged under cloudy weather
- Charging speed

- How much was charged into the battery after 30 minutes
    - Ideally, a 5V battery should be full within 9 hours
- Room light testing stage for solar panel and built-in battery:
- Test for charging
    - See whether the battery is constantly being charged under room lighting
- Charging speed
- How much was charged into the battery after 30 minutes
    - Ideally, a 5V battery should be full within 6 hours

LED Display:

- Check to see if it will display the desired information
    - Feed the display with random numbers for testing purpose through the microcontroller
- Check to see if the battery can withstand the LED requirement
    - Test for the battery requirement from the LED display
    - LED Display should not consume over 1% of the battery over one hour period

The ON/OFF switch:

- Check to see if the LED display will turn on when pressed once
- Check to see if the LED display will turn off when pressed again

Thermal Sensor + LED Display:

- Test for temperature display accuracy
- Test for cold and hot condition and range
    - Test under room temperature of approximately 25 degree Celsius
    - Test inside a freezer of approximately -5 degree Celsius
    - Test with a hair dryer of approximately 35 to 40 degree Celsius

Battery level + LED

- Test for battery level corresponding to the correct lighting from the LED
- Test for the accuracy of the battery level

- If the battery level is approximately 66~100%, LED glows green
- If the battery level is approximately 33~65%, LED glows yellow
- If the battery level runs below 33%, LED glows red

User documentation

- User manual will be provided for audience with minimal knowledge for chargers
- The manual will be provided in English, Traditional and Simplified Chinese, French, Japanese, Spanish, and German for international market
- Detailed user interface will be explained for each component
- Caution notice will be highlighted, enlarged, and bolded on the corner of the front page

Conclusion

The functional specification shows all the requirement we must meet for this product to be safe and reliable. Overcoming all the defined problem during the testing phase will be targeted before December of 2011.

Reference

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