



**Discovery Technologies Inc.**

Functional Specification  
for D-Charger Battery Pack

October 19, 2015

Dr. Andrew Rawicz  
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Simon Fraser University  
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RE: ENSC 440 Capstone Project Functional Specification for D-charger Battery Pack

Dear Dr. Rawicz,

Attached below is the functional specification document, for the Portable Re-charging Battery Pack called D-Charger. The D-Charger is an self-power generating battery pack aimed for both passive and active power generation. The aim of the device is to generate power for the battery pack for outdoors or when there is no external source of electricity provided.

Our functional specification document provides clear description of D-Charger's functional requirements, such as intended capabilities, functional constraints, sustainability and safety, and a base test plan, for proof-of-concept and production stages of development. The document will be utilized by all our members as an reference, base, and guide in the development of the product.

Discovery Technologies is comprised of five dedicated 3<sup>rd</sup> and 4<sup>th</sup> year SFU engineering students: Davison Kao, Chao Duan, Rowen Jiang, Kefan Gao, Yufan Wang. If there is any questions or concerns please contact me by email at [dkao@sfu.ca](mailto:dkao@sfu.ca).

Sincerely,

Davidson Kao  
CEO  
Discovery Technologies



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# Functional Specification For the D-Charger Battery Pack

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## Executive Summary

Nowadays, electricity has become one of the most important tool we use every day. Almost every basic devices require electricity to perform its purpose. Therefore, the D-charger Battery pack is intended as a self-generated electric device for people when there is no access to an AC source. Our motivation for this project is to develop a portable self-generated electricity power source to support our daily use of devices. D-Charger Battery pack is a helpful alternative for people, where steady electricity is not readily accessible.

This project will be split into three phases, the first of which will focus on the research of circuit design and self-generated electricity. The second phase will result in a battery pack with the following abilities:

1. The battery pack will be able to use Solar panel to absorb sun to generate electricity.
2. The battery pack will be able to use pedaling and hand cranking to generate electricity from kinetic energy.

The final phase will combine all of the features into one battery pack. The date of completing this project is December 7, 2015. The D-charger will allow people a method of generating energy during emergencies as well as for personal use in outdoor activities like camping or hiking.

Overall, this document presents the functional specifications of the D-Charger Battery Pack. Our main goal at this stage is to outline the functional specifications of our project based on the research and analysis we have done.



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## Glossary

ISO	-	International Organization for Standardization
CSA	-	Canadian Standards Association
AC	-	Alternating Current
DC	-	Direct Current



## 1. Introduction

The D-Charger battery pack is a self-generated electric device by transferring solar energy and kinetic energy into electricity that will allow people a method of generating energy during emergencies and outdoor activities.

### 1.1 Scope

This document describes the functional requirements of the D-charger battery pack, in regards to what should be implemented and what must be implemented. The requirements will describe and clarify the proof-of-concept of the device.

Project goals for the portable D-Charger battery pack are:

- Able to generate electricity without using AC port
- Passive and easy to use energy generating modules
- Portable battery module with multi ports for connecting to energy generating modules and energy requiring devices

### 1.2 Intended Audience

This functional specification document is developed for the use of all members of Discovery Technologies. The engineers will use the document as a guideline and reference in the design, development, and integration of the D-Charger Battery Pack.



### 1.3 Classification

In order to simplify the referencing and prioritizing the requirement, we will be using the following classification standard:

[Rn-p]          Functional requirement statement

Where n represents the requirements index, p represents the priority level defined below:

- I -      High priority: Requirements pertaining to the proof-of-concept system, and must be completed for the prototype.
- II -     Medium priority: A desired feature which will be implemented if time permits.
- III -    Low Priority: A refinement or addition for the final product, after all higher priority features are completed.

For example [R25-III] would define the 25th requirement, which has low priority.

## 2. System Requirements

### 2.1 System Overview

D-Charger is a system that can charge a battery by 3 different functions which is hand cranking, feet pedal, and solar panel, when away from a stable AC source. D-Charger is designed for camping, hiking, emergencies, and military use where applicable. D-Charger contains: solar panel, hand crank generator, and pressing/dynamo generator, electric adapter, circuit, AC and USB ports, and a battery. First of all, the main charging method is the solar panel and generators, where the AC charging method is secondary. And then use the circuit to transfer the generated electricity to the battery. Finally, the electric adapter will be used to convert from AC to DC or DC to AC.



Below, Figure 1 displays a high level functional block diagram of the D-Charger system

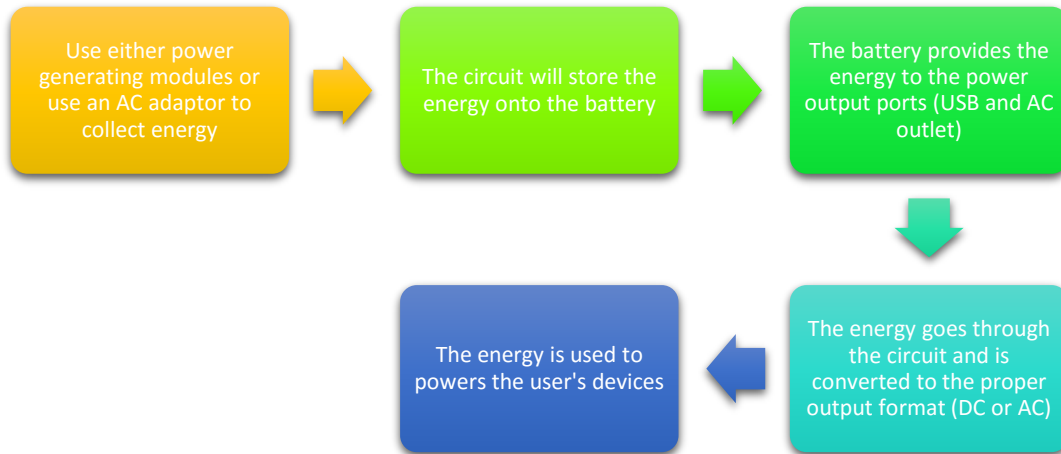


FIGURE 1: A HIGH LEVEL FUNCTION BLOCK DIAGRAM OF THE D-CHARGER SYSTEM

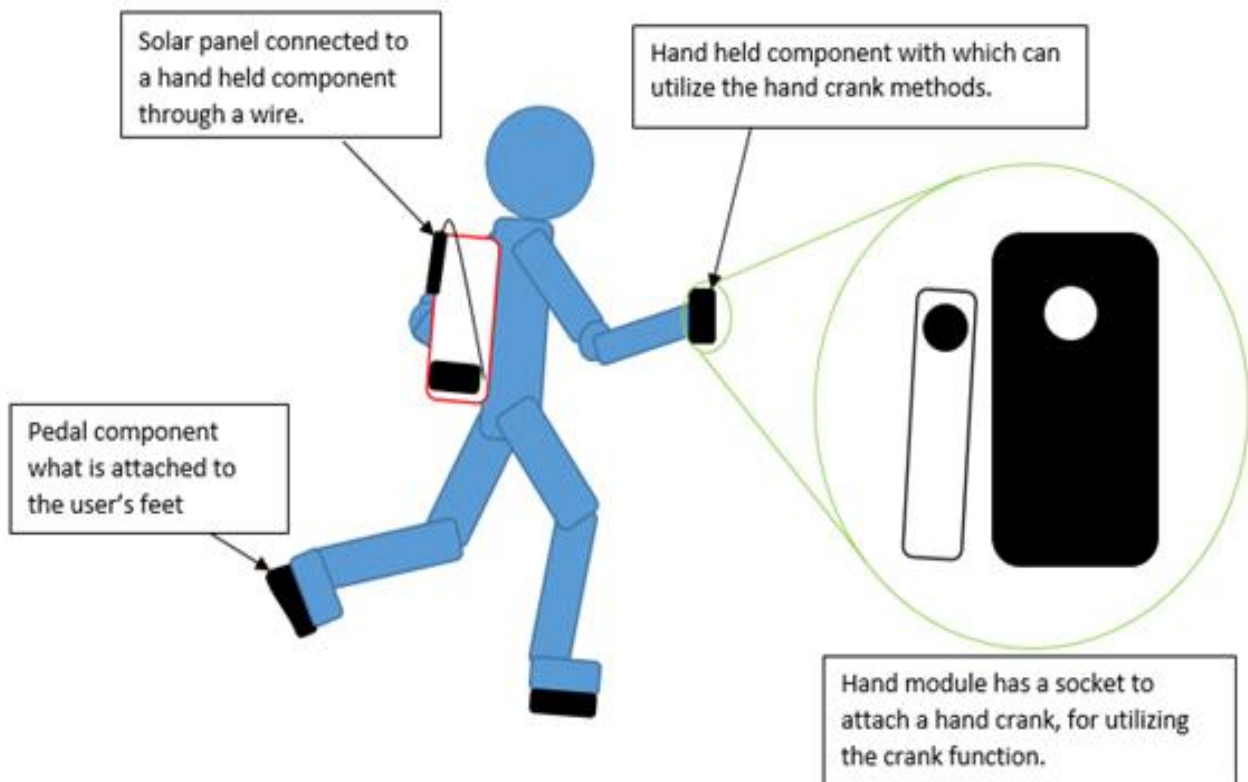


FIGURE 2: DISPLAYS THE DIFFERENT METHODS FOR GENERATING ENERGY BEING USED BY A USER





The figure above, Figure 2, displays a user using two of the charging modules while holding the hand crank module. Also in the figure you can see that the hand crank module needs to be assembled, due to the removable crank bar.

Also below, in Figure 3, there is the display of the hand crank module and the many ports that are used to charge the battery pack and the ports for using the battery pack.

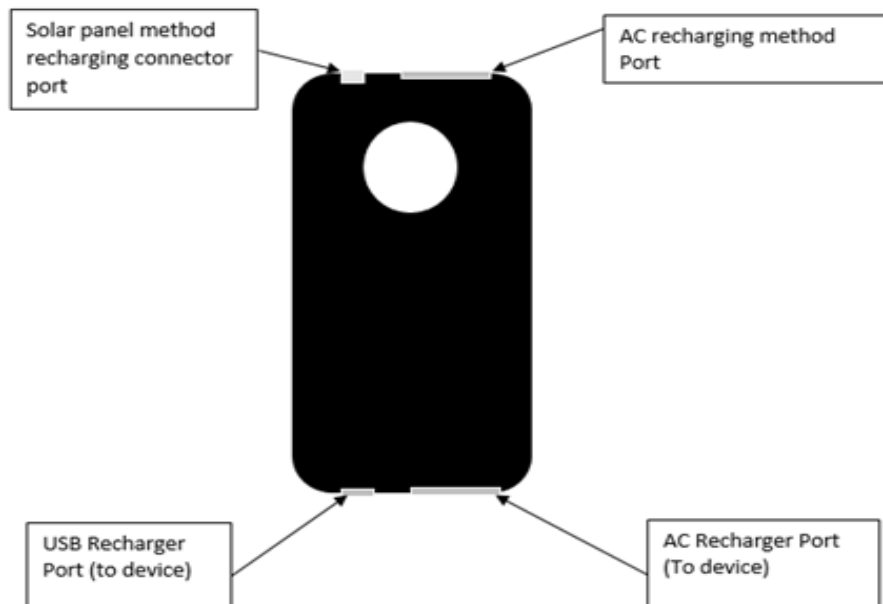


FIGURE 3: HAND MODULE WITH ITS AC AND DC (USB) CHARGER PORTS AND THE DEVICE'S BATTERY CHARGING PORTS.

## 2.2 Overall Requirements:

This section outlines the overall packaging users will receive upon purchase.

- [R1 - I] The device shall be able to connect to a standard AC power.
- [R2 - I] Each sections of the device shall be easy to set up, and shall take less than 5 minutes.



- [R3 - II] The device shall be able to use solar panel and hand cranking simultaneously.
- [R4 - II] The power generating modules can be separated or linked together for portability.

### 2.3 General Requirements:

- [R6 - III] The retail cost of this device shall not exceed \$200~\$300.
- [R5 - II] The devices as a whole shall be portable.
- [R8 - II] The device must be able to press or hand cranking over 200000 times.
- [R9 - II] The device should be easy to use without referring to the user manual.
- [R10 - II] The shell of the device must be insulation to prevent electric leakage.
- [R11 - I] Each parts shall have a label on it to indicate its function.
- [R12 - I] All of the devices shall use the same port for connecting the battery.

### 2.4 Physical Requirements:

- [R13 - II] In order to achieve a better portability and easy to use, the size of the device shall be as small as possible, when appropriate.
- [R14 - II] For portability and use, the device as a whole should not weigh over 2.5Kg
- [R15 - II] The shell of the device should be durable and strong enough to carry the weight of the user.

### 2.5 Electrical Requirements:

- [R16 - I] The device shall generate electricity in 5 Volts [1].
- [R17 - I] The energy generated must be stored into battery for future use.
- [Rn - P] The wires will all be labeled for ease of use.



## 2.6 Environmental Requirements:

- [R18 - II] The device shall work in temperature range from -15°C to 40°C.
- [R19 - III] The device shall work with a humidity level range up to 50%.
- [R20 - III] The device shall be water resistant to a certain degree.
- [R21 - II] The device shall be useable in both indoor and outdoor condition.

## 3 Feet Pedal

### 3.1 Overview

Feet pedal is a system that utilizes a pressing/dynamo mechanism, which will turn gears that turn an electricity generating motor. The module is considered a separate component which does not require the hand module circuit, to power and store energy into the battery. Meaning it uses its own hardware component when used to charge the battery. There will be a circuit to let the unstable current become continued and stable current, it can also change the AC current created by kinetic energy into DC current.

### 3.2 General Requirements:

- [R22 - I] The device shall not largely impact the user's ability to walk.
- [R23 - I] The device shall be able to attach to shoes ranging in sizes.
- [R24 - I] The pressed component shall be able to return to the original position after one cycle.

### 3.3 Physical Requirements:

- [R25 - II] The size of the pedaling device shall be made adjustable to fit the shoe of the user, which will have a minimum size for the main portion of the module.
- [R26 - II] The complete module shall be no heavier than 1kg per feet.



- [R27 - II] Each component of the pedal shall be easy to operate.
- [R28 - I] The outer shell shall be durable enough to withstand the user's weight.
- [R29 - II] The shell shall be made waterproof for rain or humid environment.

### 3.4 Electrical Requirements:

- [R30 - I] All electronics component shall be assembled within a casing.

## 4 Hand Crank

### 4.1 Overview

The Hand Crank Module will be the component that has a detachable crank bar, for the crank generator. The use of gears will help in advancing the turning speed enough for the motor to generate enough energy. The energy generated will proceed through the circuit and be stored on the battery. This component will also have a port to connect to the solar panel, AC charging port (for the battery), a USB port and AC port for exporting the energy stored in the battery.

### 4.2 General Requirements:

- [R33 - I] The gears shall be produced enough speed to generate the required power.
- [R34 - I] The device must be insulation.

### 4.3 Physical Requirements:

- [R35 - I] All of the components must be stored in a small box (shell) that can be easily held in the hand.
- [R36 - II] The length shall be less than 6 cm and the width shall be less than 3 cm.
- [R37 - II] The whole module will not weigh more than 1Kg.



#### 4.4 Electrical Requirements:

- [R31 - I] The output of the USB shall be around 5V.
- [R32 - I] The module should have a port for connecting the solar panel.
- [RN - I] The module should produce an AC output for the AC Port.
- [RN - II] There should be a port for charging the battery using an AC outlet (may use a 3rd party AC Adaptor).

### 5 Solar Panel

#### 5.1 Overview

Solar panel will be used as a passive way to convert solar energy to electrical energy. From this the electrical energy shall be moved through a wire connected to the hand crank module to charge the battery.

#### 5.2 General Requirements:

- [R40 - I] The solar panel shall be able to attach to any article of clothing or bag.
- [R41 - II] The device shall not largely impact the user when it is attached to the clothing or bag.
- [R42 - I] The module shall be able to produce enough electricity to charge the battery
- [R43 - III] The device shall be water and dust proof.
- [R44 - I] The solar panel connection wire shall remain in normal operation when encountering shaking.
- [R45 - II] The device shall have stable current during charging when in optimal conditions.



### 5.3 Physical Requirements:

- [R46 - II] The solar panel must be smaller than 10cm by 10cm.
- [R47 - I] The total weight of the solar panel shall be less than 1 Kg, for easy to carry during outdoor activity.

### 5.4 Electrical Requirements:

- [R48 - III] The efficiency shall reach at least 25% during sunny days.
- [R49 - II] The voltage shall no larger than 6V and the maximum current shall be less than 120mA, the power shall be about 0.72W.

### 5.5 Environmental Requirements:

- [R50 - I] The solar panel should require direct sunlight or light source to operate effectively.

## 6 User interface:

- [R51 - II] The whole device should be easy to assemble and interpret the functions.

## 7 Documentation

Below will be some requirements for the documentation of the device, for intentions of providing an easy to understand, for assembly and use, user manual.

- [Rn - I] The manual will be provided, in the package, with the purchase of the device.
- [Rn - II] The manual will provide diagrams to support understanding and use.
- [Rn - II] The manual will be written in everyday language so that users can easily understand.
- [Rn - II] The manual should be understandable for users with post-elementary reading comprehension level and above.



## 8 Standards

- [R52 - I] The D-Charger shall meet ISO 50001:2011 [2].
- [R53 - I] All connections shall meet CSA C22.1-15 [3].
- [R54 - I] The plugin section shall meet the requirement of North American Standard Voltage (110V) at 60Hz AC.

## 9 Reliability and Sustainability

- [R55 - II] The D-Charger should withstand the 24 hours charging through different method.
- [R56 - II] The D-Charger should avoid any electric leakage under normal operating.
- [R57 - III] The use life time of D-Charger shall be at least 2 years.
- [R58 - II] The total charging cycles of charger should between 300-500 cycles [1].
- [R59 - I] The charger shall be able to charge at least 1 phone, regularly sold in the market.
- [R60 - III] The solar panel charger and hand cranking generator shall provide the electricity to balance of the phone battery level (in idle mode).
- [R61 - I] The D-Charger shall provide stable current to the charging device.
- [R67 - I] The different electric generators and battery are highly recyclable.

## 10 Safety

- [R62 - I] The wires on charger shall not tangle the user to avoid harming.
- [R63 - I] The generator in the shoe shall not injure the foot of the user.
- [R64 - I] The battery will not explode under heavy use.
- [R65 - II] The main body of D-Charger should not have sharp edges.
- [R66 - II] The outer shell of battery use insulating material to avoid electrocuting the user.



## 11 Conclusion

The functional specification in this document demonstrates the requirements and standards that will be held for D-charger. According to our current design, the D-charger is separated into 3 main charging methods being: solar panel, hand crank, and feet pedal modules. Each charging method is then subdivided to further allow better comprehension for the designing process.

In order to prioritize our main functional requirements for the project, we have divided the requirements into 3 levels, labeled as “I, II, III”. The requirements with “I” have the highest priority and must be fulfilled, “II” defining medium priority which is preferred to be included in the prototype if time permits, and “III” as an end production model which can be added when there is time. By doing this, we can make sure we always focusing on the most important things and do not let any other more irreverent tasks to overshadow the main objective.

Lastly, all the requirements is based on the functional and safety importance in the system. We are working on the proof-of-concept model and we will evolve it to a marketable model. We expect it can be successfully completed by Dec/7/2015.





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