Self Sustainable Electric Golf Bag

Design Review

Jonathan Kinney - Cory Edwards - Harrison Kantner
ECE 445: Senior Design at UIUC
Mustafa Mukadam
25 February 2013

Table of Contents

Introduction

1.1 Project Statement

This project was chosen because we feel there is a need to be able to keep beverages cool while enjoying a round of golf without the hassle of walking back and forth between the clubhouse. Currently, there are no similar items on the market that can complete this goal while also providing the added features proposed within our golf bag. Our group has had experience with golfing, and each member is excited about the idea of a golf bag that does more than simply hold your clubs. This is also a great opportunity to learn new concepts while also applying those we have learned throughout our academic careers.

1.2 Objectives:

Goals:

- Create a solar rack that can be easily attached to a golf bag
- Design a cooling system that has variable temperatures
- Create a digital scorecard used to keep score
- Enable charging of battery via home outlet
- Allow charging of USB devices from on-bag battery

Functions:

- Solar Panel or AC input acts as source of power, charging battery
- Microcontroller used to regulate temperature as well as keep score
- Thermoelectric modules used to heat/cool insulated pouch
- Power electronics used to ramp up/step down voltages as needed
- LCD with keyboard to display temperature and score

Benefits:

- Allows golfers to have cold beverages in warm weather and vice versa
- Can now enjoy a round of golf without worrying about phone charge
- Can power any USB device
- Keep score in an easy to read format
- Have the most advanced golf bag on the course

Features:

- Heating and cooling pouch
- Temperature control via keyboard control
- Digital Scorecard displayed via LCD
- USB power
- Solar power
- AC outlet charging capabilities

2.0 Design

2.1 Block Diagram

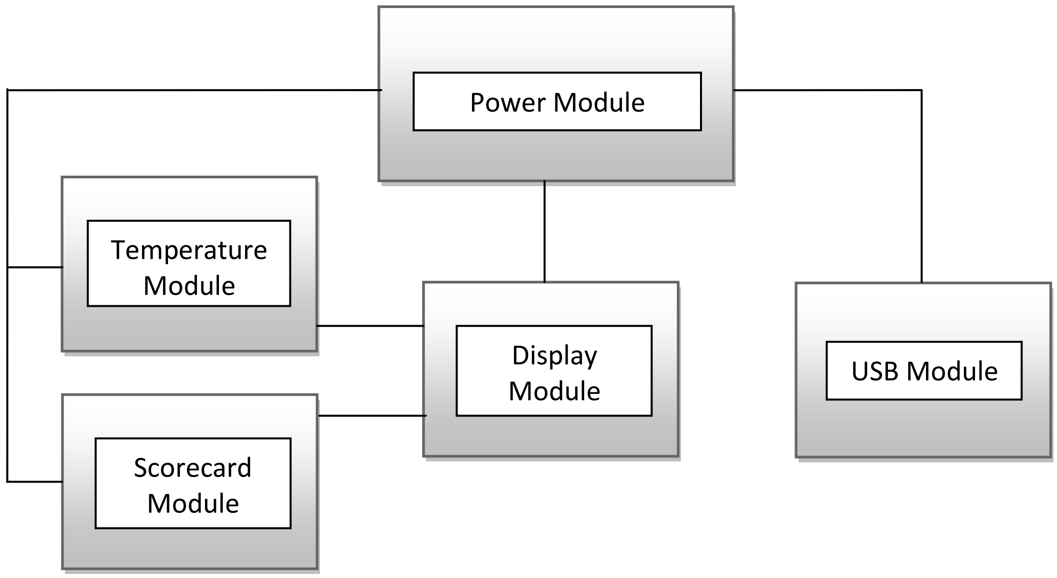


Figure 1: Top Level System Layout

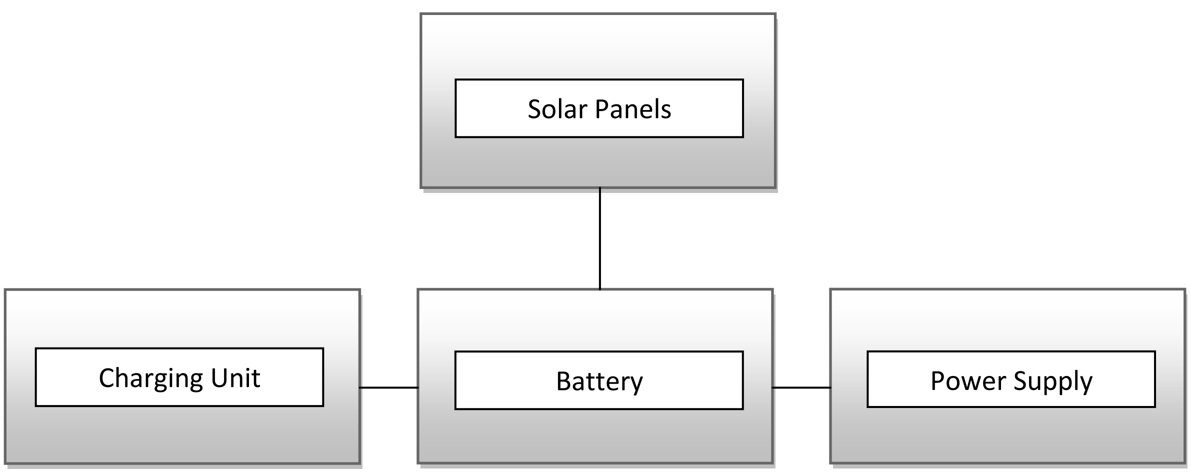


Figure 2: Power Module Block Diagram

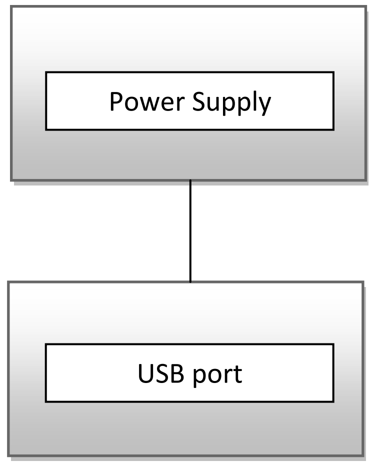


Figure 3: USB Module Block Diagram

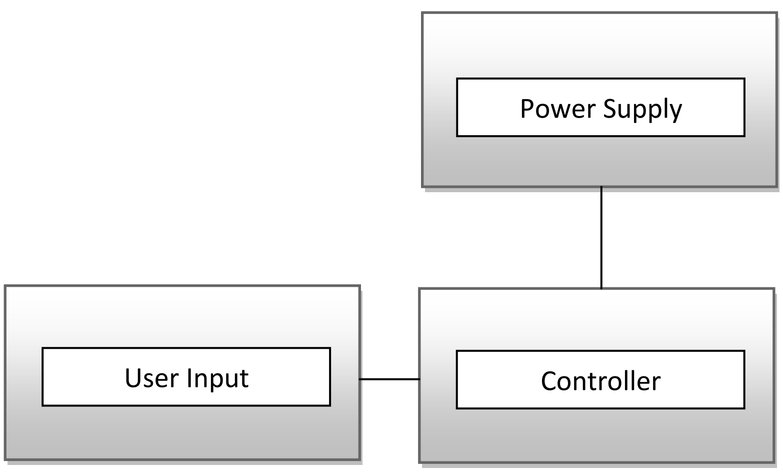


Figure 4: Scorecard Module Block Diagram

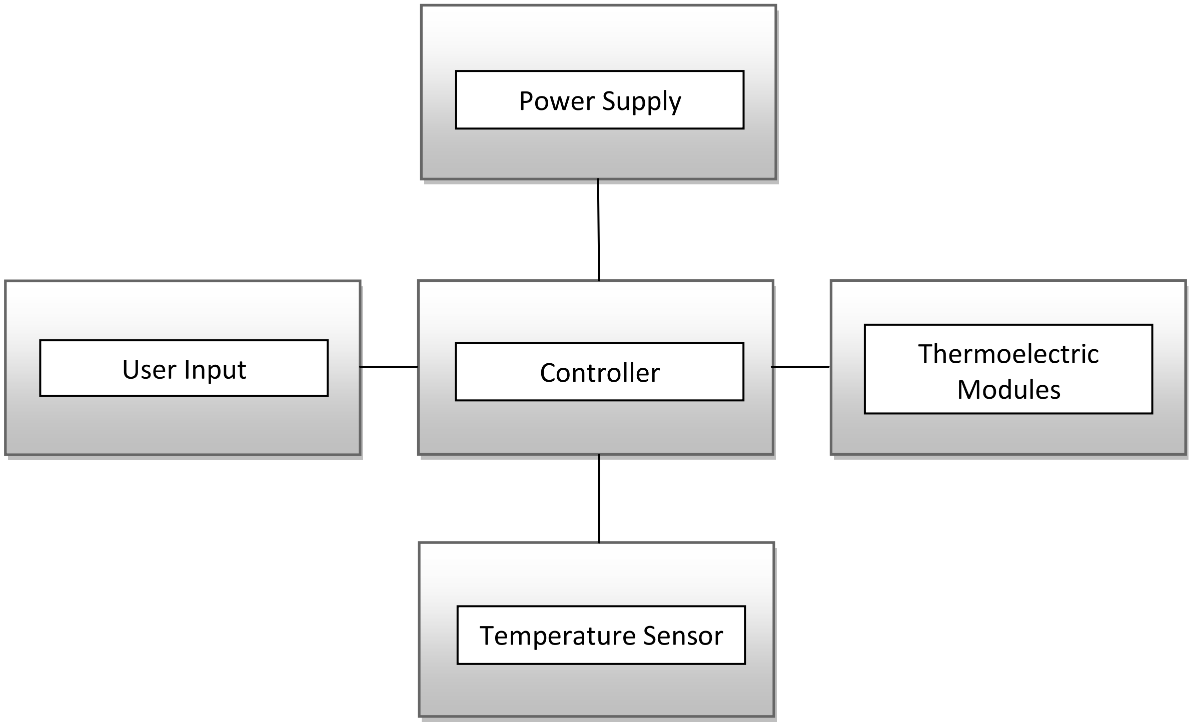


Figure 5: Temperature Module Block Diagram

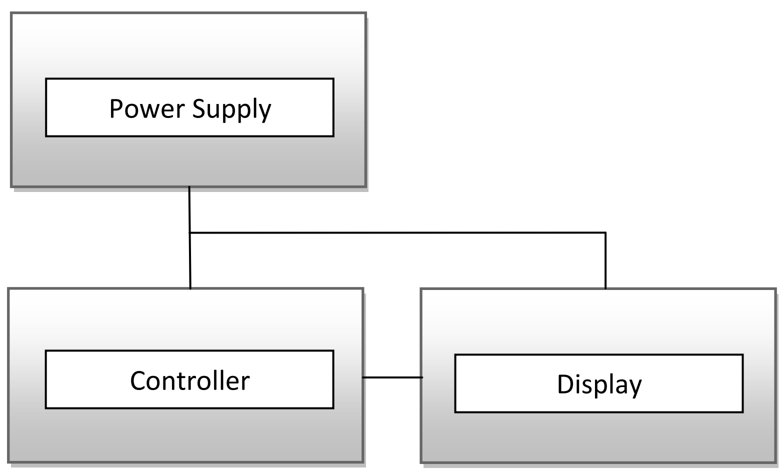


Figure 6: Display Module Block Diagram

2.2 Block Descriptions

Power Module

Overall, the Power Modules acts as a power supply for the entire system by generating, storing, and distributing appropriate power to each component.

Solar Panels

Solar panels will be the primary power generation component of the power module. Under ideal conditions, the solar panels will generate all of the power used by the entire system. A power budget calculation estimates 25W as the maximum power consumed by the system. Therefore, panels rated at a total of 30W will be used. Power from the solar panels would not be consistent enough to directly power all of the components. Instead, the panels will recharge a battery.

Charging Unit

The charging unit allows the battery to be charged by a wall outlet for when solar panels cannot be used. An AC-DC converter will modulate the power which will be scaled into a usable source for the battery.

Battery

The battery is responsible for storing power generated by the solar panels. In addition to being recharged by solar power, the battery will also be capable of being charged through an ordinary wall outlet (in case the weather does not favor solar power.) The battery will output the approximated 25W to a power supply sub-block.

Power Supply

The power supply takes the 25W power from the battery and converts it into usable voltages for every other component in the system (USB, Scorecard, Display, and Temperature Modules.) These voltages are 7.4V, 5V, and 3.3V.

USB Module

The USB Module is a very simple component that takes power distributed from the power supply and sends it to a USB port. The power will already be scaled by the Power Module to our desired 2.2W for the USB port, so there will be very little circuitry.

Scorecard Module

The Scorecard Module will be an electronic version of the scorecards received at any golf course. It will generate a grid for a single player to enter in their score after each hole. A running counter will keep a total for the player.

Power Supply

The power supply comes from the Power Module. It is a source of power (two lines) for both the display and microcontroller in the Scorecard Module. Because the display and microcontroller are used in other modules, this power supply component is shared between the Temperature and Display Modules.

2User Input

The user input for the Scorecard Module is a group of buttons used to navigate the scorecard and enter in numbers. Signals from the buttons are sent to the controller to be processed.

Controller

The controller is a device responsible for processing our coded scorecard, powered by the power supply and driven by user input. We will code a GUI for the scorecard, load it on to the controller, and send it to the Display Module.

Temperature Module

The Temperature Module is a feedback control system that will allow the user to set a desired temperature for an insulated pocket in the bag, and maintain that temperature through the use of thermoelectric modules.

Power Supply

The power supply is a source of power from the Power Module, used by the microcontroller in the Temperature Module. This power will already be regulated to the temperature module's specifications as it enters the Temperature Module. The MC is ran at battery voltage, 7.4V.

User Input

The user input for the Temperature Module will be two buttons to set the desired temperature of the pocket (one to increase the temperature and another to decrease it.) Signals from the buttons are sent to the controller to be processed.

Temperature Sensor

A simple temperature sensor will be used to provide feedback into the control system. This sensor has a data output/input line that will send the temperature as a 16 bit, binary code. This value is then interpreted by the controller to determine if the modules should heat up, cool down, or simply turn off.

Thermoelectric Modules

Thermoelectric modules (Peltier coolers) will be used to change the temperature of the pocket. They are solid-state devices that convert an electric voltage into a temperature difference. When our controller determines that there is an error between the user-selected reference value and the temperature of the pocket, a voltage will be applied to these modules to create a temperature differential.

Controller

The controller will use the user-selected temperature as well as feedback from a temperature sensor to determine if the Peltier cooling devices need to be running. It will operate based on a closed-loop transfer function in which the output of the system is fed back through the sensor measurement to a reference value. The controller will take the error between these values and correct accordingly by enabling/disabling the Peltier devices to cool/heat the bag. This will be done by sending signals to a series of 4 mosFets, directing current in the appropriate direction through the modules.

Display Module

The Display Module consists of two LCD screens and a controller that will display the electronic scorecard GUI and temperature information, sent by the Scorecard and Temperature Module.

Power Supply

The power supply is a source of power (2 lines) from the Power Module, used by the controller and display. The appropriate power values will have already been determined by the Power Module and sent directly to these components.

Controller

The controller sub-block in the Display Module represents the controller in the Scorecard and Temperature Module. All information that needs to be displayed will have already been processed by each respective block. Therefore, the information will be ready to be displayed on screen.

Display

Low resolution LCD screens will be used to display the electronic scorecard and temperature information. This information will come from the controller. The display will be mounted on the bag in a location that is easy for the user to access. Similarly, the screen will need to be low-glare so that it is easy to use outside.

2.3 Power Module Schematics

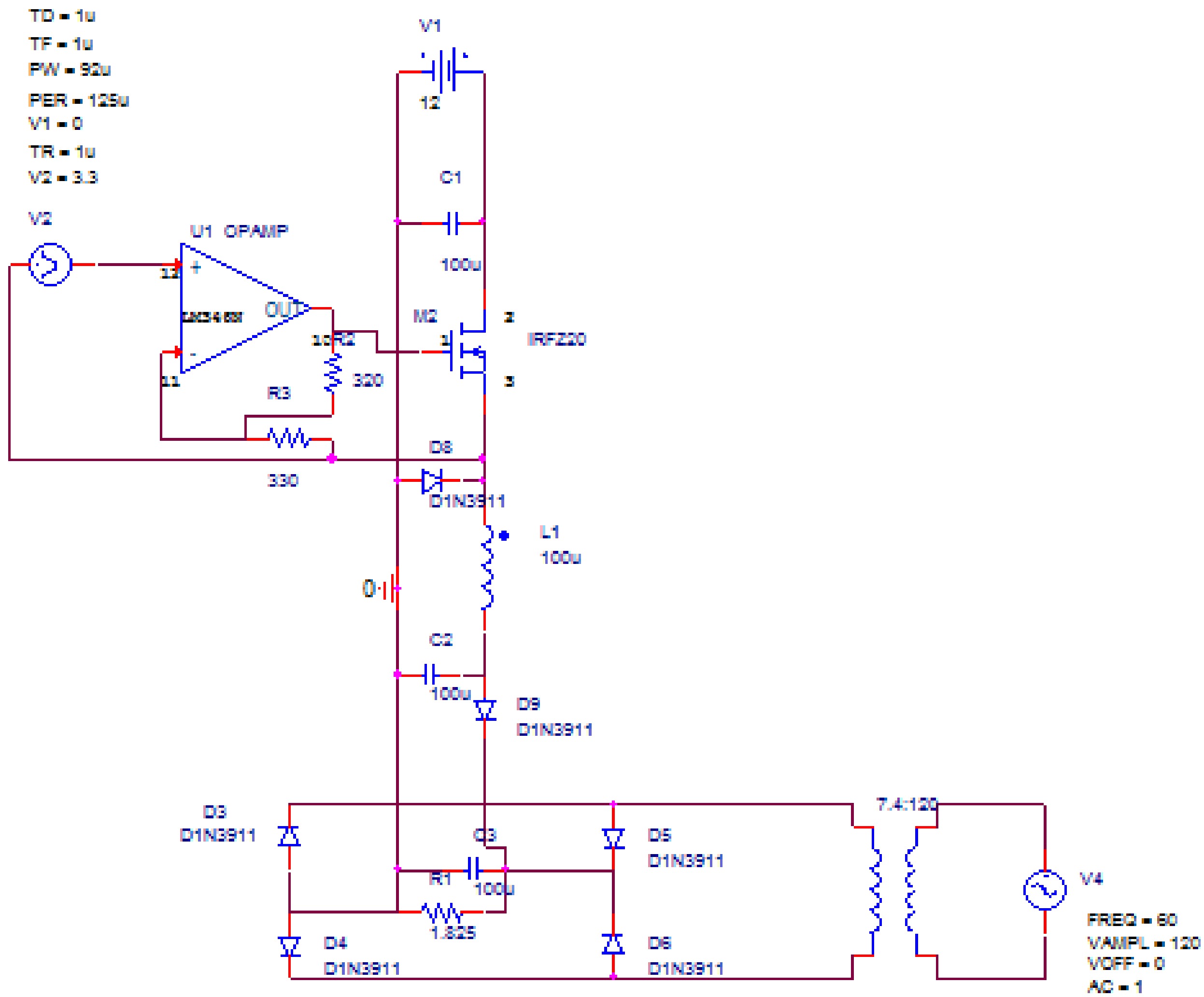


Figure 7: Power Module with 12V - 7.4V Buck Converter and 120VAC to 7.4VDC Transformer

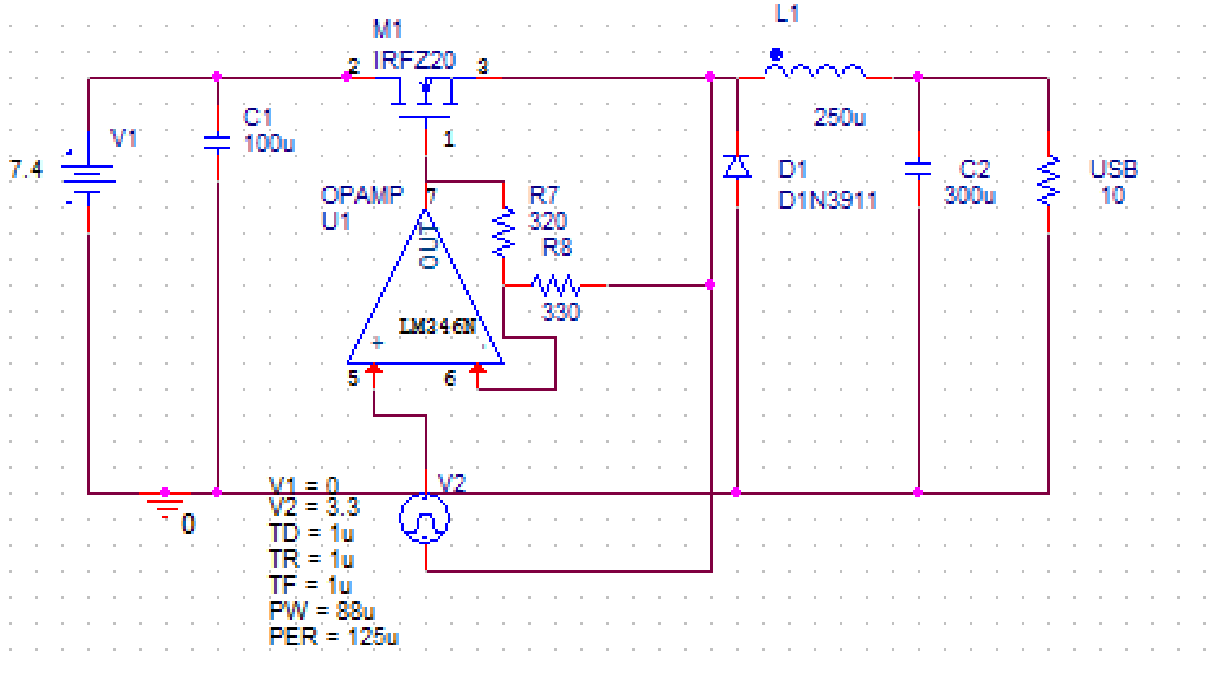


Figure 8: 7.4V - 5V Buck Converter

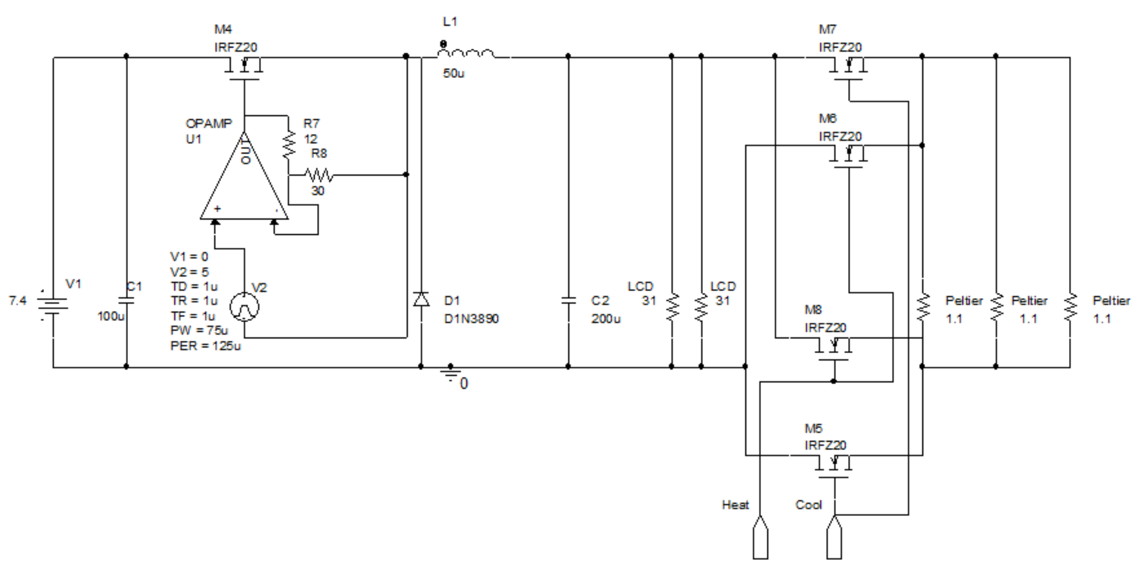


Figure 9: 7.4V - 3.3V Buck Converter

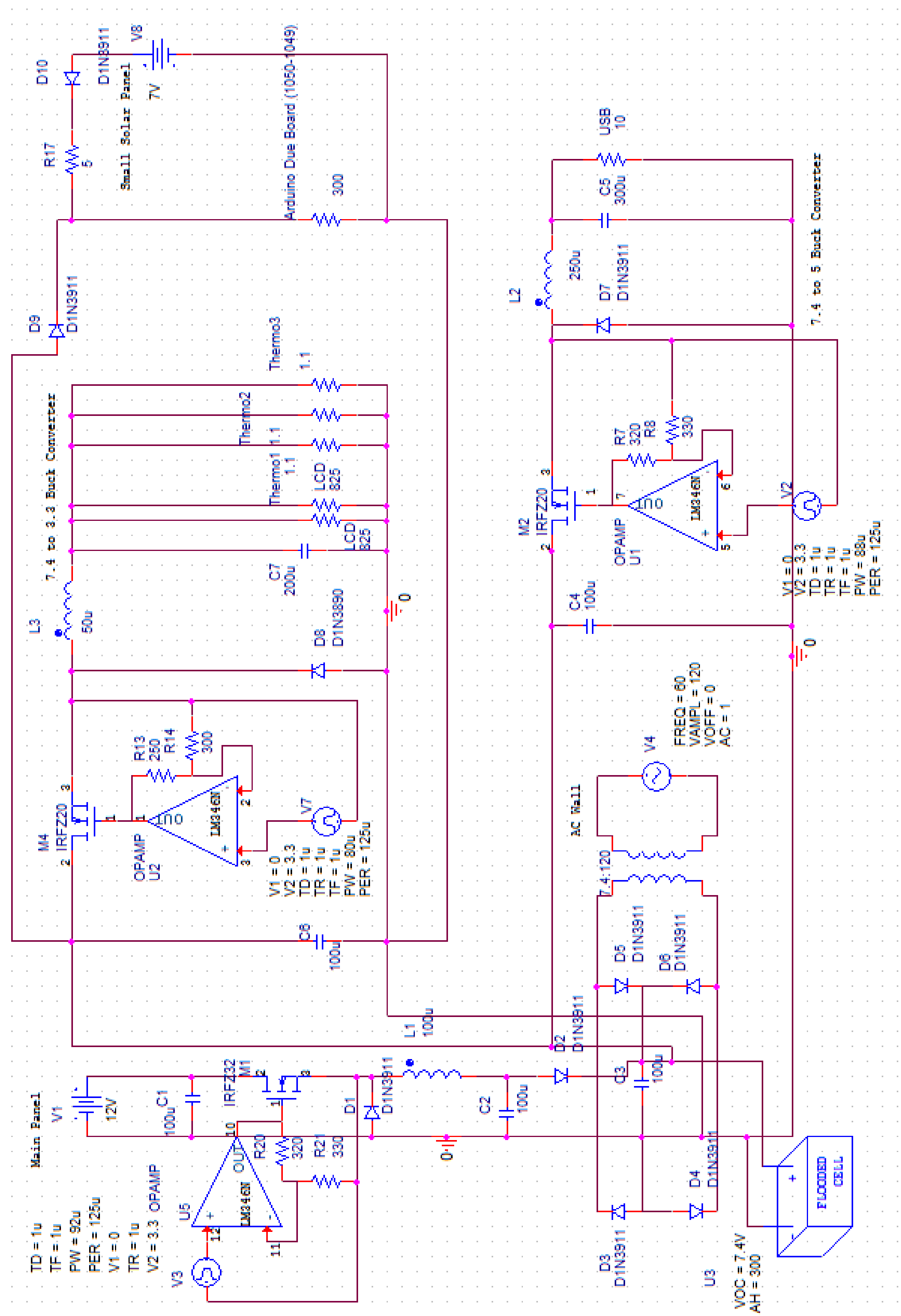


Figure 10: Full Power Circuit

2.4 Power Module Calculations

Buck Converters Inductors Minimums to avoid DCM

$$V = IR \rightarrow \frac{V}{R} = \frac{P}{V} = \langle i \rangle$$
$$\frac{V_{out}}{V_{in}} = D$$
$$T = \frac{1}{f} = \frac{1}{8000Hz} = 125\mu s$$
$$\Delta i = 2 \times \langle i \rangle,\ \ V_L = V_{in} - V_{out}$$
$$V_L = L\frac{\Delta i}{\Delta t} = \frac{L2\langle i \rangle}{D_1 T} \rightarrow L = \frac{V_L D_1 T}{2\langle i \rangle}$$

12V-7.4V

$$V_L = V_{in} - V_{out} \rightarrow 12 - 7.4 = 4.6V$$
$$\frac{P}{V} = \langle i \rangle \rightarrow \frac{30W}{7.4V} = 4.05\ A$$

$$\Delta i = 2 \times \langle i \rangle \rightarrow 2 \times 4.05 = 8.10\ A$$

$$\frac{V_{out}}{V_{in}} = D = \frac{7.4}{12} = 0.6167$$
$$L_{min} = \frac{V_L D_1 T}{2\langle i \rangle} \rightarrow \frac{4.6 \times 0.6167 \times 125\mu}{8.10} = 43.8\mu H$$

7.4V-5V

$$V_L = V_{in} - V_{out} \rightarrow 7.4 - 5 = 2.4V$$
$$\frac{V}{R} = \langle i \rangle \rightarrow \frac{5V}{10\Omega} = 0.5\ A$$

$$\Delta i = 2 \times \langle i \rangle \rightarrow 2 \times 0.5 = 1\ A$$

$$\frac{V_{out}}{V_{in}} = D = \frac{5}{7.4} = 0.675$$
$$L_{min} = \frac{V_L D_1 T}{2\langle i \rangle} \rightarrow \frac{2.4 \times 0.675 \times 125\mu}{1} = 202.7\mu H$$

7.4V-3.3V

$$V_L = V_{in} - V_{out} \rightarrow 7.4 - 3.3 = 4.1V$$
$$\frac{V}{R} = \langle i \rangle \rightarrow \frac{3.3V}{0.366\Omega} = 9\ A$$

$$\Delta i = 2 \times \langle i \rangle \rightarrow 2 \times 9 = 18\ A$$

$$\frac{V_{out}}{V_{in}} = D = \frac{3.3}{7.4} = 0.446$$
$$L_{min} = \frac{V_L D_1 T}{2\langle i \rangle} \rightarrow \frac{4.1 \times 0.446 \times 125\mu}{18} = 12.7\mu H$$

Mosfet Signal Op Amp

$$V_{out} = V_{in}\left(1 + \frac{R_f}{R_g}\right)$$
$$7V = 5\left(1 + \frac{120k}{300k}\right)$$

Stresses

Mosfet 7.4V-5V (M2)

$$V_{Stress} = V_{oc} = 7.4 - 5 = 2.4V$$
$$I_{stress} = I_{in} = I_{out} \times D = 0.5 \times 0.675 = .3375\ A$$
$$P_{stress} = V_{Stress} \times I_{Stress} = 2.4 \times .3375 = .81\ W$$

Mosfet 7.4-3V (M4)

$$V_{Stress} = V_{oc} = 7.4 - 3.3 = 4.1V$$
$$I_{stress} = I_{in} = I_{out} \times D = 9 \times 0.446 = 4.01\ A$$
$$P_{stress} = V_{Stress} \times I_{Stress} = 4.1 \times 4.01 = 16.46\ W$$

Mosfet 12V-7.4V (M1)

$$V_{Stress} = V_{oc} = 12 - 7.4 = 4.6V$$
$$I_{stress} = I_{in} = I_{out} \times D = 4.05 \times 0.6167 = 2.5\ A$$
$$P_{stress} = V_{Stress} \times I_{Stress} = 4.6 \times 2.5 = 11.5\ W$$

Power Budget

USB

$$V = 5V, I = 0.5\ A,$$

$$P = V \times I \rightarrow 5 \times 0.5 = 2.5\ W$$

Arduino Due Board

$$V = 7.4V, I = 0.025\ A,$$

$$P = V \times I \rightarrow 7.4 \times 0.025 = 0.185\ W$$

LCD

$$V = 3.3V, I = 0.004\ A,$$

$$P = V \times I \rightarrow 3.3 \times 0.004 = 0.0132\ W$$

$$P_{LCD} = 2 \times 0.0132 = 0.0264W$$

Thermoelectric Modules

$$V = 3.5V, I = 3.3\ A,$$

$$P = V \times I \rightarrow 3.5 \times 3.3 = 11.55\ W$$

$$P_{Modules} = 2 \times 11.55 = 23.1W$$

Op Amp

$$V = 12V, I = 0.001\ A,$$

$$P = V \times I \rightarrow 12 \times 0.001 = 0.012\ W$$

Total Power

$$P_{Total} = 2.5 + 0.185 + 0.0264 + 23.1 + 0.012 = 25.82\ W$$

2.5 Power Module Simulations

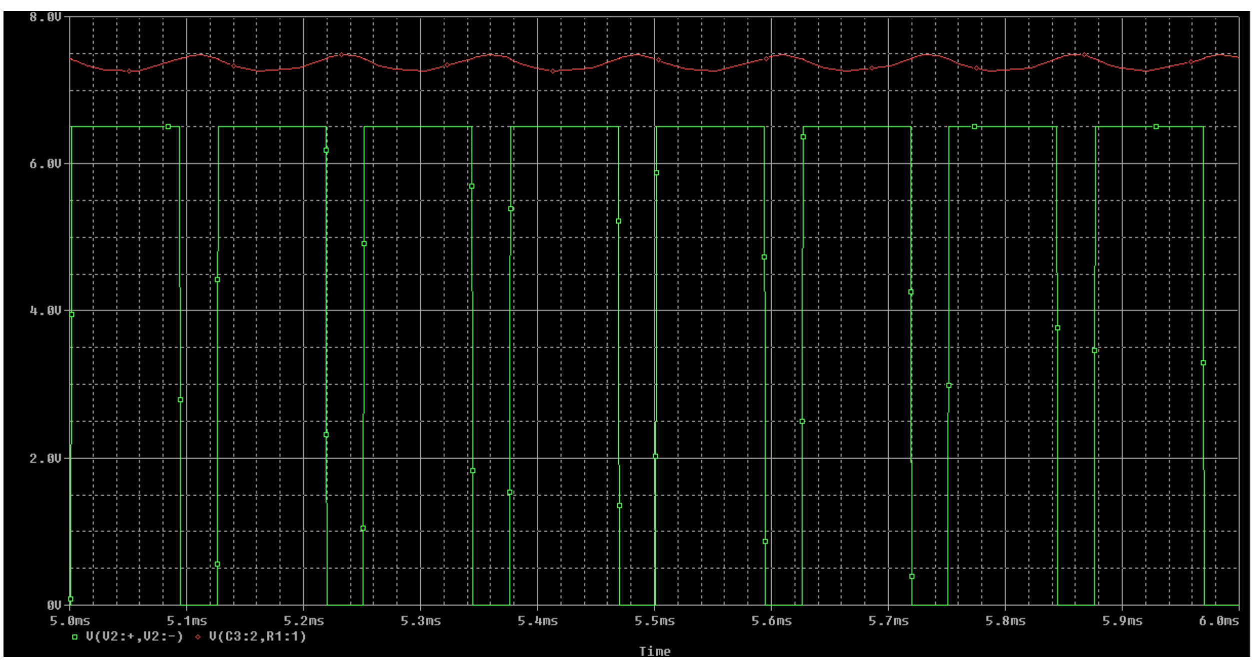


Figure 11: 12V - 7.4V Buck Converter

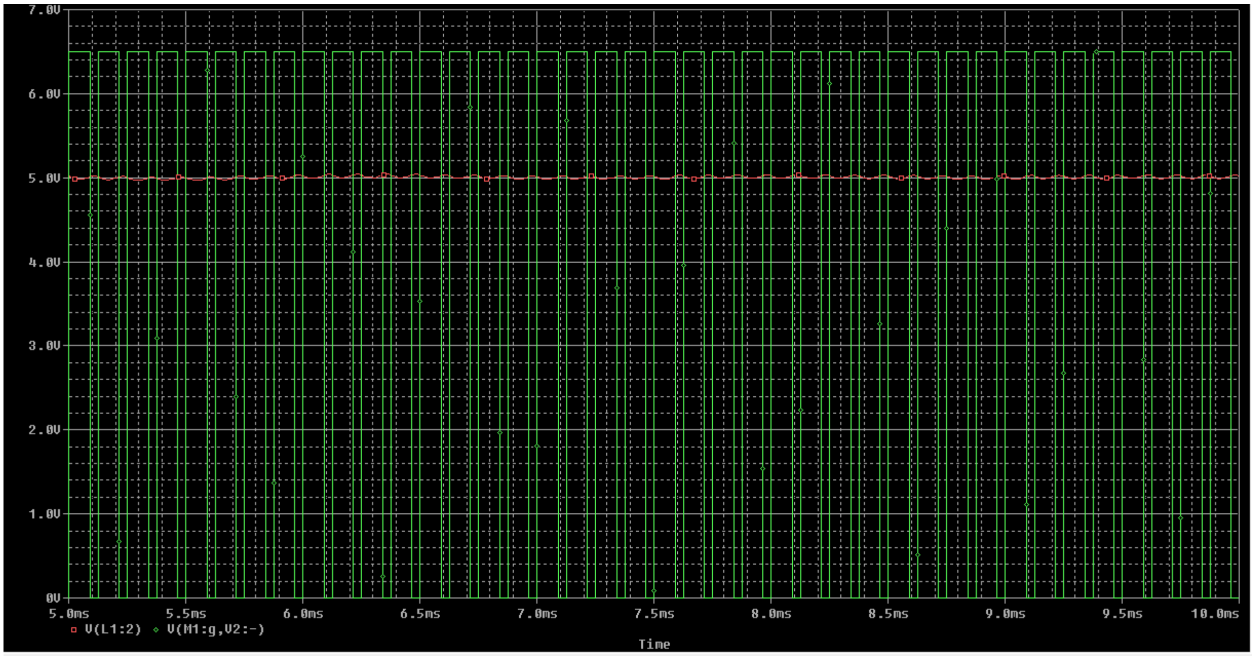


Figure 12: 7.4V - 5V Buck Converter

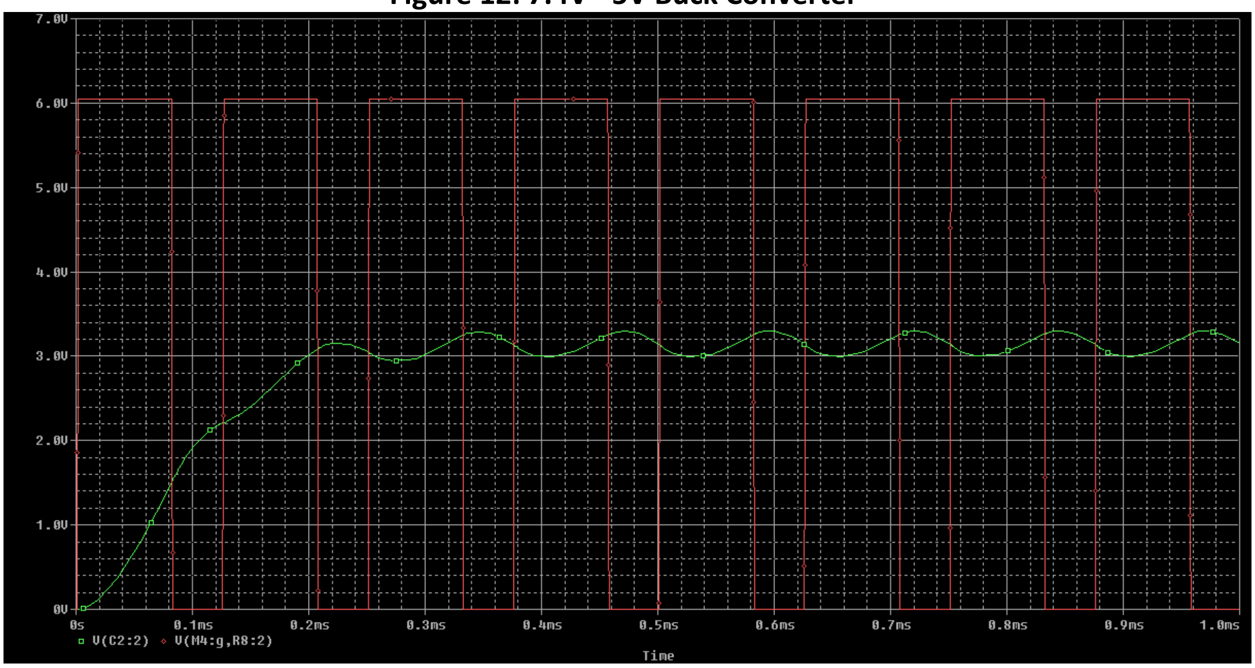


Figure 13: 7.4V - 3.3V Buck Converter

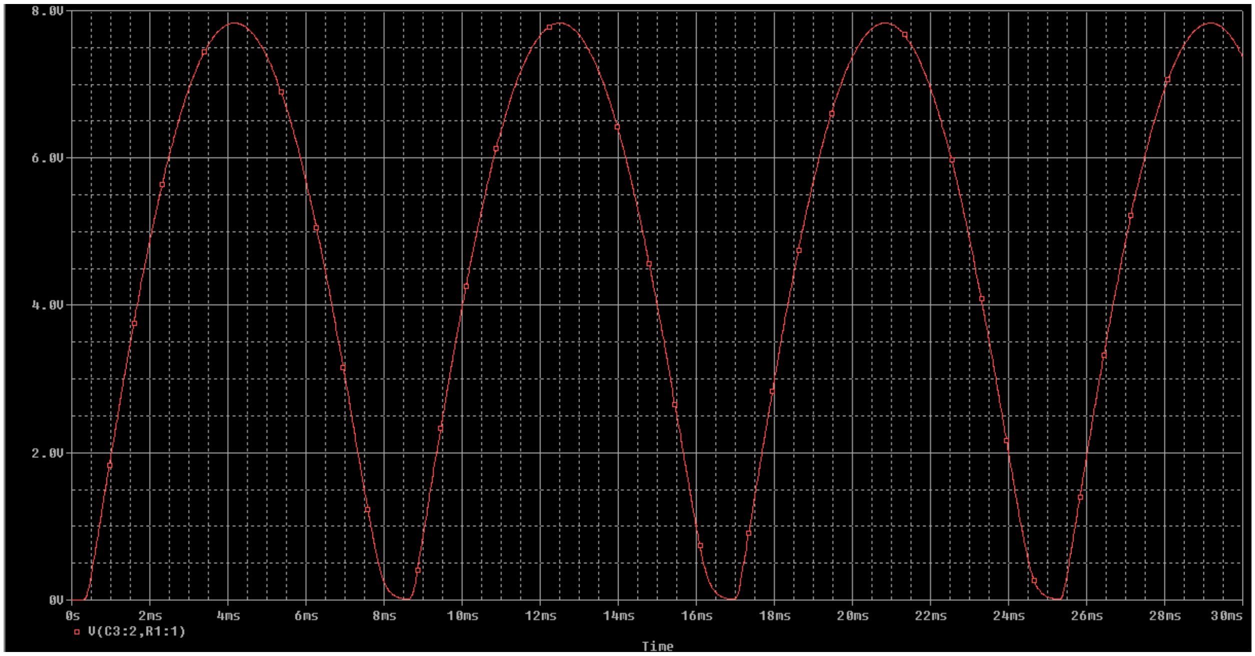
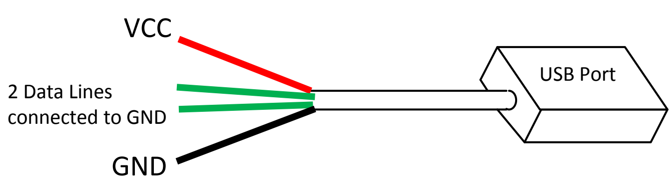


Figure 14: Power Supply Rectifier

2.6 USB Module Pin-Out



2.7 Scorecard Module Logic

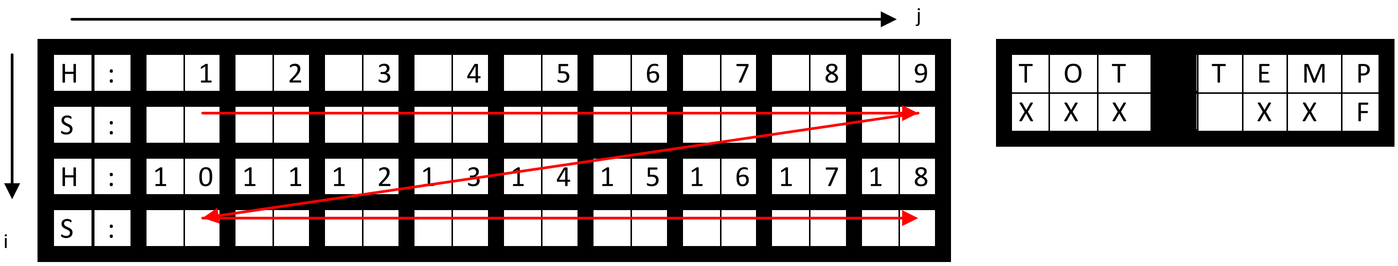


Figure 15: Scorecard Display Layout (4x20 AND 2x8 segment displays)

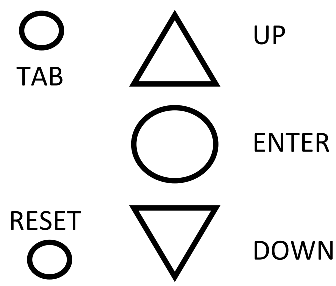


Figure 16: Input Button Layout

Abbreviations for Scorecard Flowchart:

- R = Reset
- U = Up button pressed
- D = Down button pressed
- E = Enter button pressed
- i = Cursor i position (1:4)
- j = Cursor j position (1:20)
- Sij = Score at position i,j (1:9)

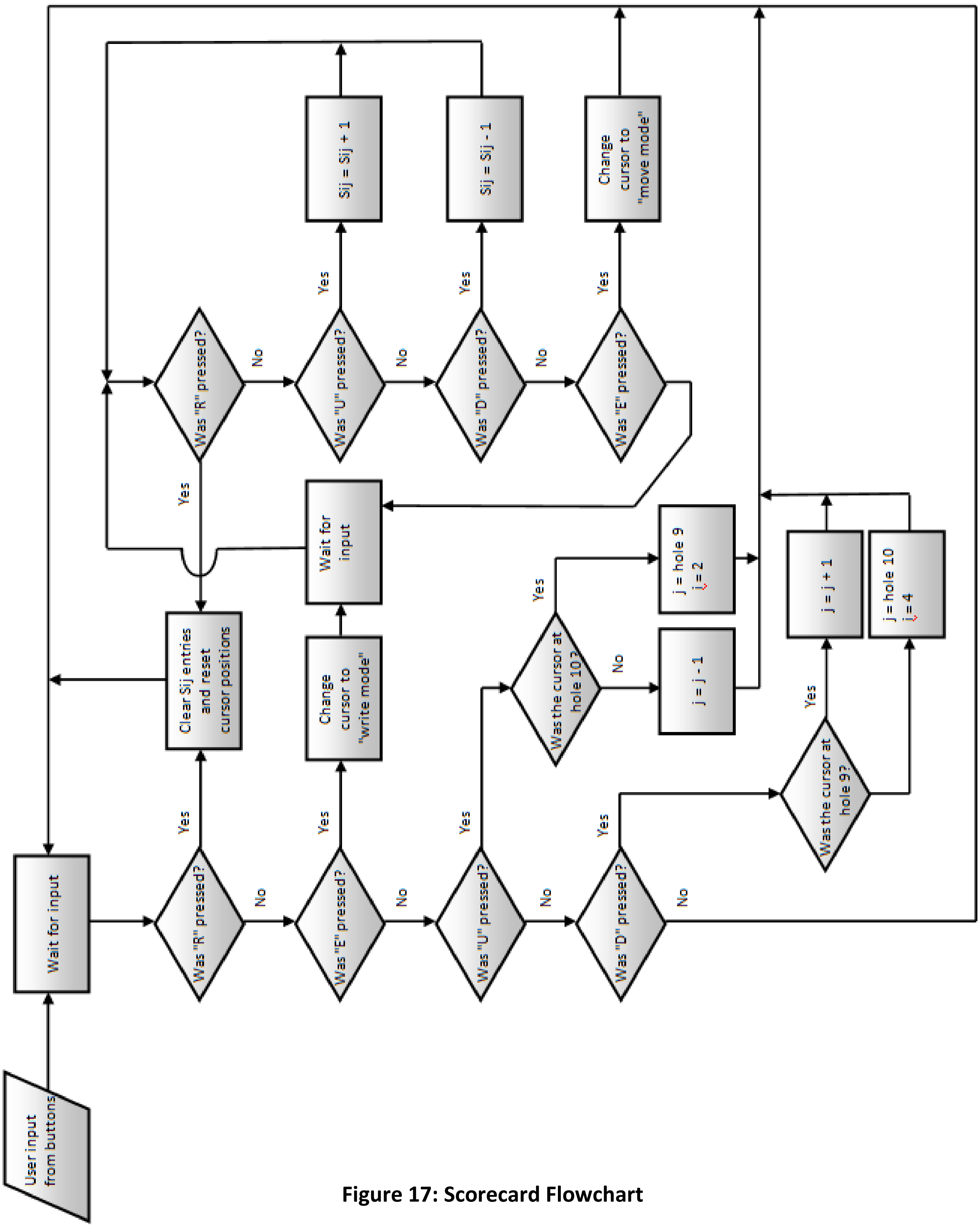


Figure 17: Scorecard Flowchart

2.8 Temperature Module Logic

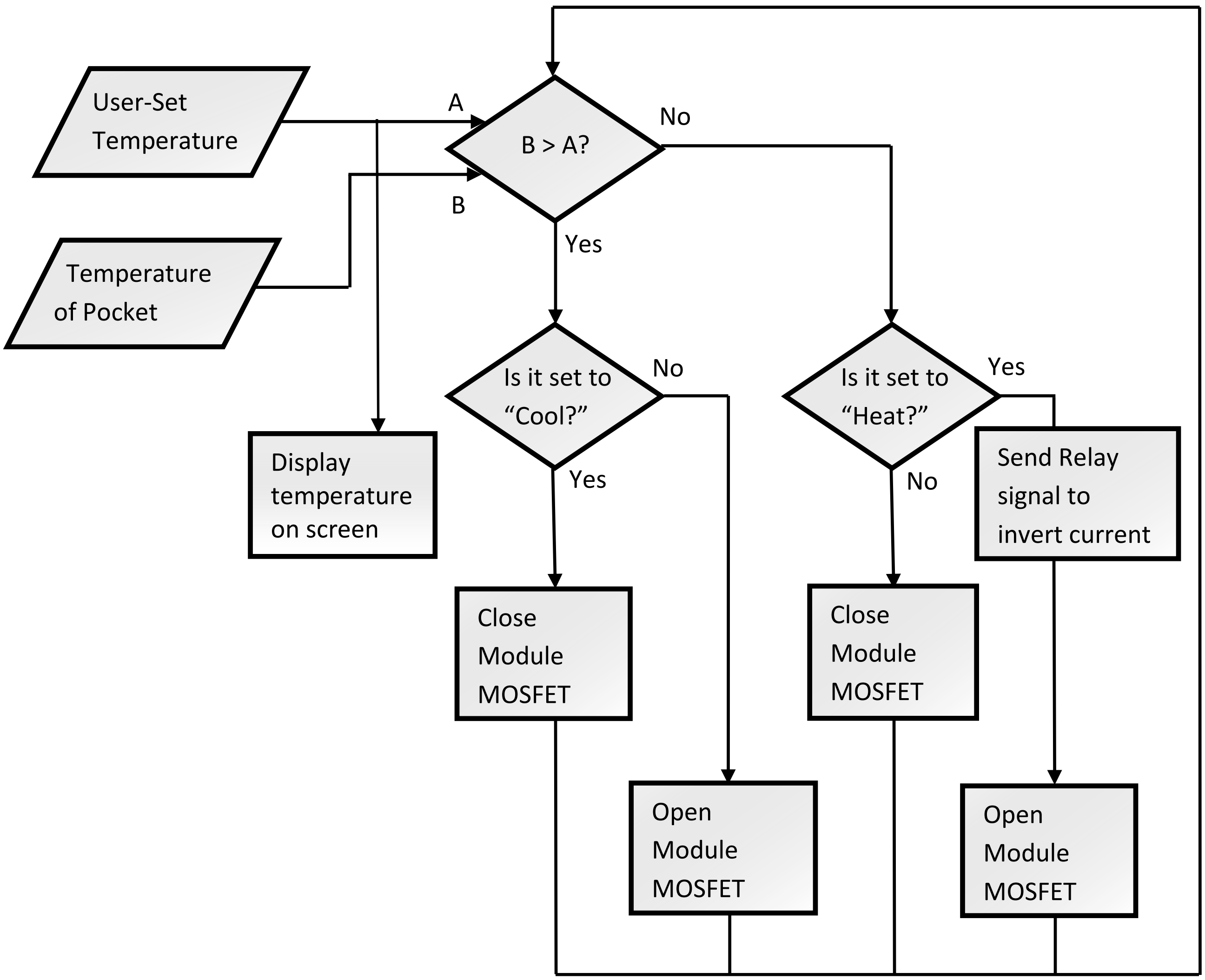


Figure 18: Temperature Flowchart

2.9 Controller Pin-Out with User Input and Display Interface

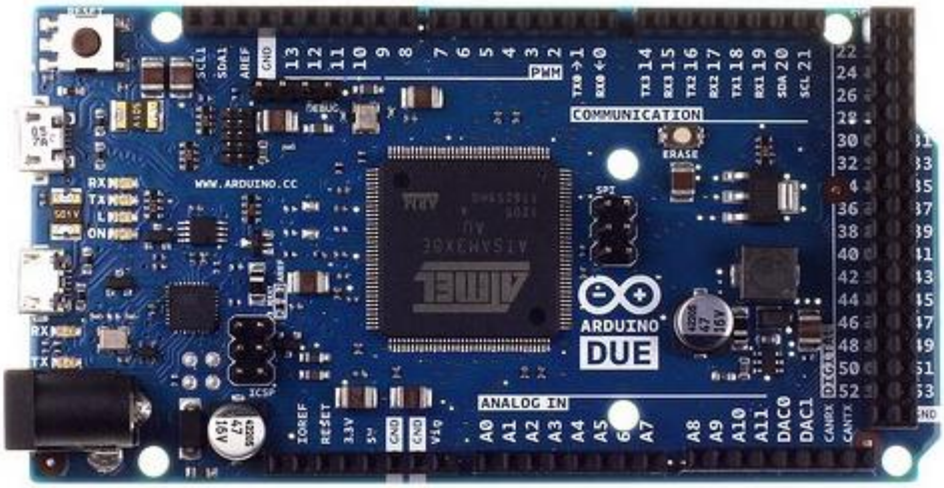


Figure: 19: Top-Down Arduino Due Board (1050-1049-ND) [Ardumania]

Figure 20: Top-Down 4x20 Display (NHD-0420H1Z-FSW-GBW-33V3) [Digikey]

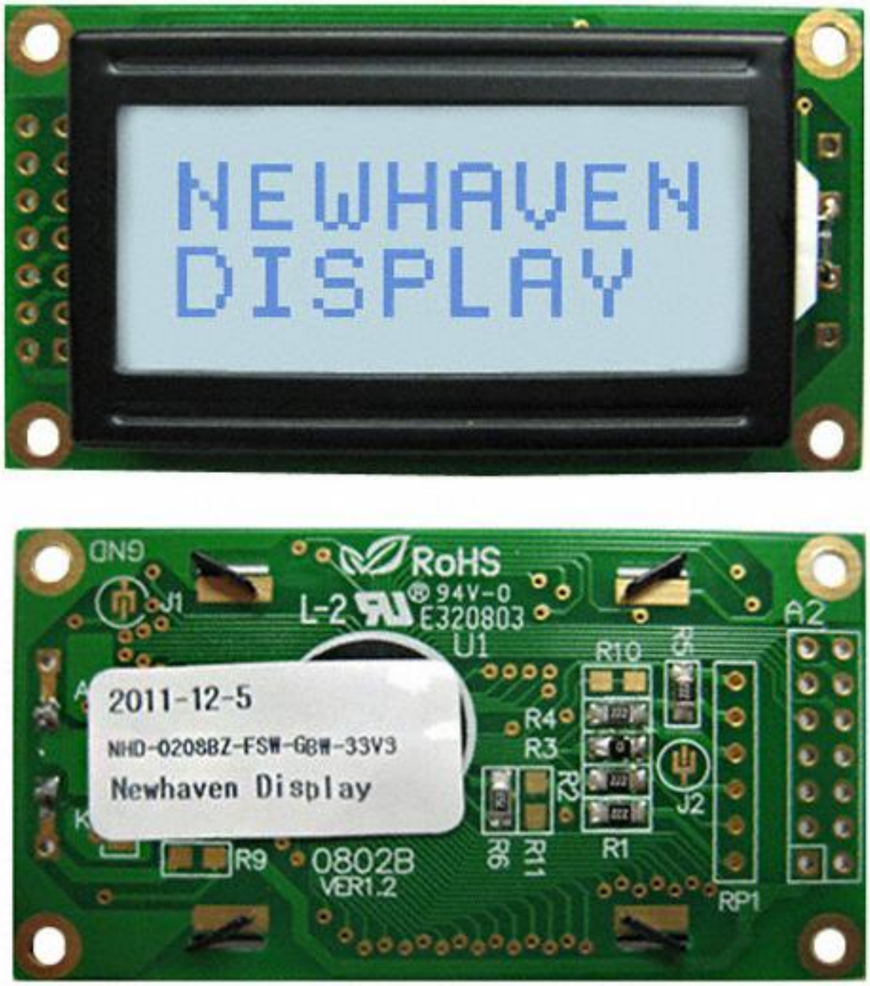


Figure 21: Top-Down 2x8 Display (NHD-0208BZ-FSW-GBW-33V3-ND) [Digikey]

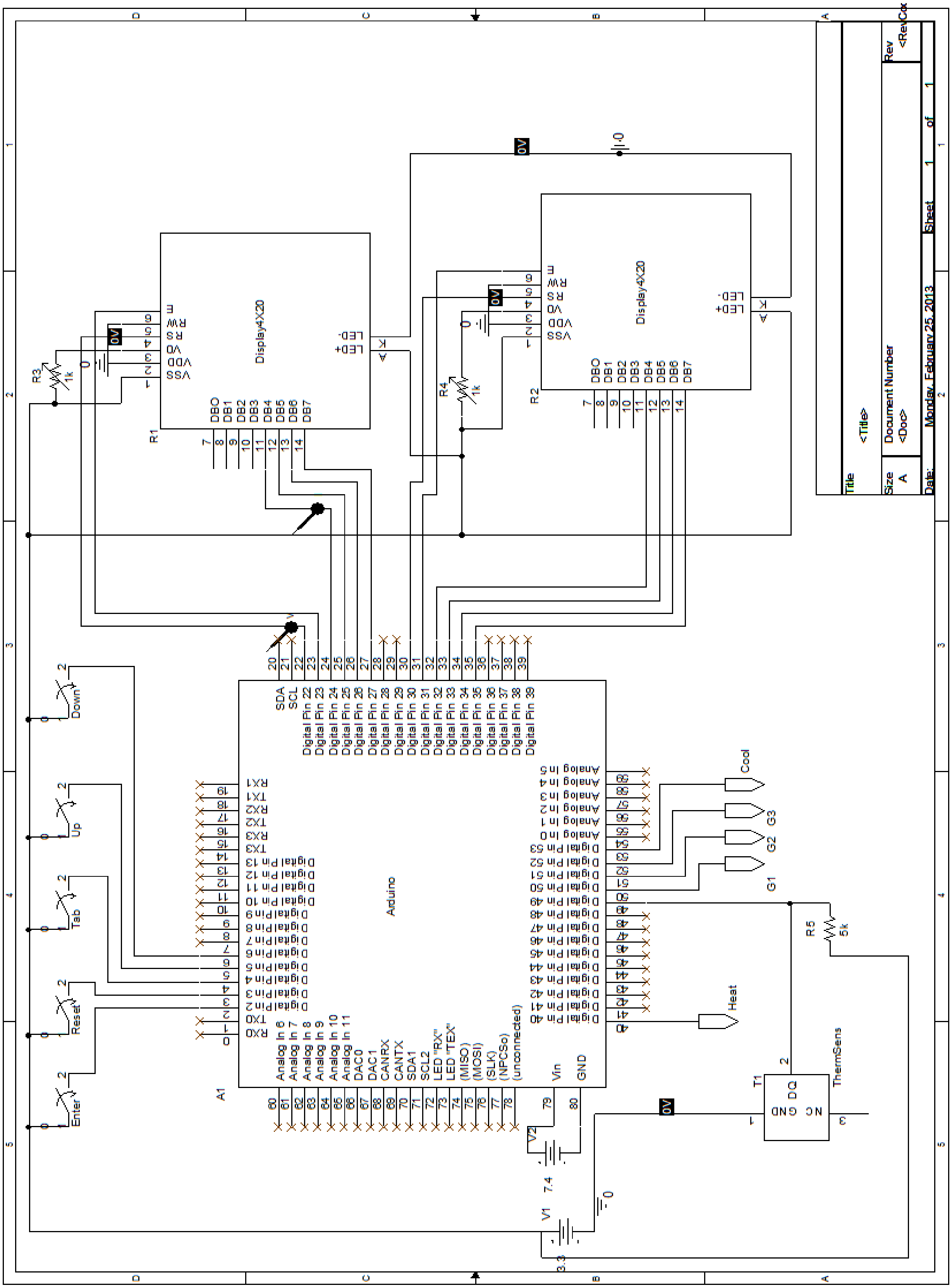


Figure 22: Arduino, Temperature Sensor, and Display Pin-Out

3.0 Requirements and Verification

3.1 Power Module Requirements and Verifications

Requirements	Verification
Main Solar Module: 1) Main solar panel open circuit voltage is near rated value when operating outside under typical golf conditions	Main Solar Panel: 1) Verify open circuit voltage is 12V +/- 10% using a DMM
2) Solar panel voltage is reduced to battery voltage	2) Verify that solar panel voltage is reduced from the 12V open circuit voltage to 7.4V +/- 10% under the load of the buck converter
a. Op-amp amplifies gating signal	a. Verify that the output voltage is 6.8V +/- 5% using a 3.3 V DC source input and differential voltage probe across the output
b. Converter gate switches at necessary frequency with correct duty cycle	b. With a 8kHz, 67.5% duty cycle square wave (created by function generator) applied to the gate of our IRFZ20, use an oscilloscope to monitor drain voltage
Secondary Solar Module: 1) Secondary solar panel open circuit voltage is near rated value when operating outside under typical golf conditions	Secondary Solar Panel: 1) Verify open circuit voltage is 7V +/- 20% using a DMM
Wall Source: 1) Wall adapter properly converts wall AC voltage to battery DC voltage	Wall Source: 1) Verify adapter open circuit voltage is 7.4V +/- 5% AC with small ripple
Battery: 1) Open circuit voltage is near rated value when powered by the main solar panel operating outside under typical golf conditions.	Battery: 1) Verify open circuit voltage is 7.4V +/- 10% using a DMM
2) Open circuit voltage is near rated value when powered by the wall outlet.	2) Verify open circuit voltage is 7.4V +/- 10% using a DMM
a. A/C wall signal is full wave rectified	a. An oscilloscope across the rectifier

to ensure proper charging capacity	output yields a full wave signal
3) Ensure stable battery operating when connected to both the main solar panel and wall source	3) Charge battery outside using the main solar panel under typical golf conditions. Simultaneously charge the battery with the wall source rectifier. Confirm voltage does not exceed 7.4V +20%
<u>5V Power Supply:</u> 1) Battery voltage is reduced to necessary module voltage	<u>5V Power Supply:</u> 1) Verify that the battery voltage is converted down from 7.4 V to 5 V +/- 10% under the load of the buck converter
a. Op-Amp amplifies gating signal	a. Verify that the output voltage is 6.8V +/- 5% using a 3.3 V DC source input and differential voltage probe across the output
b. Converter gate switches at necessary frequency with correct duty ratio.	b. With an 8kHz, 67.6% duty cycle square wave (created by function generator) applied to the gate of our IRFZ20, use an oscilloscope to monitor drain voltage
<u>3.3V Power Supply:</u> 1) Battery voltage is reduced to necessary module voltage	<u>3.3V Power Supply:</u> 1) Verify that the battery voltage is converted down from 7.4 V to 3.3 V +/- 10% under the load of the buck converter
a. Op-Amp amplifies gating signal	a. Verify that the output voltage is 6.8V +/- 5% using a 3.3 V DC source input and differential voltage probe across the output
b. Converter gate switches at necessary frequency with correct duty ratio.	b. With an 8kHz, 44.6% duty cycle square wave (created by function generator) applied to the gate of our IRFZ20, use an oscilloscope to monitor drain voltage

3.2 USB Module Requirements and Verifications

Requirements	**Verifications**
<u>USB Port:</u> 1) USB port must be able to power all USB devices a. USB leads must have rated voltage across leads	<u>USB Port:</u> 1) Plug in a USB device to see if it charges a. Use DMM to perform continuity test and measure the voltage supplied to USB leads to verify 5V +/- 5%

3.3 Scorecard Module Requirements and Verifications

Requirements	**Verifications**
<u>Controller:</u> 1) Bug-free software a. Displays constant scorecard images b. Toggle between “move mode” and “write mode” c. Cursor moves correctly when in “move mode” d. Able to change score in “write mode” e. Scorecard keeps running total f. Scores are cleared and cursor position moves back to hole 1 when Reset is pressed twice	<u>Controller:</u> 1) Test scorecard program a. Confirm image upon startup b. Press enter to switch between modes c. Set to “move mode” and use up/down buttons to verify cursor movement d. Set to “write mode” and use up/down buttons to change score e. Enter multiple hole scores and verify that sum is updating correctly each time f. Press reset twice after adding in scores

3.4 Temperature Module Requirements and Verifications

Requirements	**Verifications**
<u>Temperature Sensor:</u> 1) DS18B20-PAR outputs a 16-bit temperature	<u>Temperature Sensor:</u> 1) Check the DS18B20-PAR output for non-zero data (square wave) using oscilloscope.
<u>Controller:</u> 1) Must be able to accurately interpret the data received from DS18B20-PAR temperature sensor.	<u>Controller:</u> 1) Compare the temperature reading from our DS18B20-PAR to a thermocouple
2) Receives and interprets key presses regarding temperature	2) Use DMM to measure that a signal is sent when a key is pressed. Verify that temperature on display changes.
3) Sends correct output signals to Thermoelectric Modules	3) Use DMM to verify that controller outputs gating signals to Thermoelectric Module MOSFET gates
a. Cools pouch when lower temperature is set	a. Set a temperature that is colder than pouch temperature and use oscilloscope to verify “cold” signal goes high
b. Warms pouch when higher temperature is set	b. Set a temperature that is colder than pouch temperature and use oscilloscope to verify “heat” signal goes high.
<u>Thermoelectric Modules:</u> 1) Ensure that proper regulated voltage is supplied to the modules	<u>Thermoelectric Modules:</u> 1) Verify supply voltage to thermoelectric modules is 3.3V +/- 10% using DMM
2) Temperature differential is consistent based on ambient temperature	2) Measure temperature across the thermoelectric plates using temperature probe. Ensure difference is greater than 50°
3) When current direction is changed modules switch from heating to cooling	3) Switch control MOSFETs to change current direction. Use a temperature probe to verify temperature change on thermoelectric plates

4) Heat by-product dissipates safely	4) Measure the air temperature immediately outside of the pocket. Confirm that air temperature is < 160^{o}

3.5 Display Requirements and Verifications

Requirements	**Verifications**
<u>Display:</u> 1) 4x20 display turns on when given supply voltage (NHD-0420H1Z-FSW-GBW-33V3) g. Backlight operates	<u>Display:</u> 1) Input voltage to the NHD-0420H1Z-FSW-GBW-33V3 display is 5V a. Verify when Pin 15 is connected to 5V the screen illuminates
2) 2x8 display turns on when given supply voltage (NHD-0208BZ-FSW-GBW-33V3-ND) a. Backlight operates	2) Input voltage to the NHD-0208BZ-FSW-GBW-33V3-ND display is 5V a. Verify when Pin 15 is connected to 5V the screen illuminates
<u>Controller:</u> 1) 4x20 LCD (NHD-0420H1Z-FSW-GBW-33V3) displays correct images sent from the Arduino	<u>Controller:</u> 1) Send test code to display (NHD-0420H1Z-FSW-GBW-33V3) and confirm image
2) 2x8 LCD (NHD-0208BZ-FSW-GBW-33V3-ND) displays correct images sent from the Arduino	2) Send test code to display (NHD-0208BZ-FSW-GBW-33V3-ND) and confirm image

3.6 Tolerance Analysis

There are two components that are critical to the overall system; the first being the solar cell panel. This panel needs to produce at least as much power that will be consumed, about 25W. The planned panel is capable of 30W generation. To test how consistent the power generation is, a wattmeter can be used to measure the power generated under varying conditions of light. The entire device must be tested when receiving less than desired power to observe possible effects to the system.

The second crucial component is the temperature sensor. This temperature sensor must produce resistances values within 5% of the expected value at any given temperature. If this temperature sensor is not accurate enough, the microcontroller and Peltier modules will not be able to control the temperature as desired. To test these values, a simple ohmmeter will suffice. The temperature sensor can be placed in environments that will simulate the extremes expected during a typical golf game.

3.7 Ethical Considerations

1. "To accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment"

    In achieving functionality, we will design our product with the welfare of its users in mind.

3. "To be honest and realistic in stating claims or estimates based on available data"

    We will ensure to the best of our ability that all calculations are accurate and simulations are realistic. All experimental claims will be supported by such calculations and simulations in order to provide honest data.

6. "To maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations"

    We will strive to create a safe, working product by applying the knowledge and experience of all group members. Similarly, we understand our limitations and will not allow them to compromise the well-being of others.

7. "To seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others"

Within the group, we will communicate our ideas, provide feedback, and accept criticism with an open mind. All members will act towards accomplishing a common goal of bettering the quality of our project. Information collected for outside sources will be properly credited.

4.0 Cost and Schedule

4.1 Cost Analysis

Name	Hourly Rate	Total Hours Invested	Total = Hourly Rate x 2.5 x Total Hours Invested
Cory Edwards	$30.00	170	$12,750
Jon Kinney	$30.00	170	$12,750
Harrison Kantner	$30.00	170	$12,750
Total		510	$38,250

Item	Quantity	Unit Cost ($)	Cost ($)
Arduino Due Board (1050-1049-ND)	1	50.57	50.57
4X20 CHAR LCD GRY (NHD-0420H1Z-FSW-GBW-33V3)	1	18.75	18.75
2X8 CHAR LCD GRY (NHD-0208BZ-FSW-GBW-33V3-ND)	1	10.10	10.10
StarTech 6in USB 2.0 Cable (USBMBADAPT)	1	3.39	3.39
Thermoelectric/Peltier Module (03111-5L31-03CG)	3	$14.50	43.50
10k Ohm Potentiometer (NHD-0420H1Z-FSW-GBW-33V3)	2	1.47	1.47
Instapark 20W Solar Power Panel (SP-20)	1	64.25	64.25
Instapark 10W Solar Power Panel (SP-10)	1	39.95	39.95
Thermal Bag	1	2.00	2.00
Gen Ace 120V to 7.4V adaptor (98P-Adaptor)	1	17.66	17.66
1N4005 Diode	5	0.20	1.00
Golf Bag	1	100.00	100.00
NMos Transistor (IRFZ20PBF)	3	1.57	4.71
Metal Rack	1	100.00	100.00
Resistors, Capacitors, and Inductors	-	40.00	40.00
PCB	1	40.00	40.00
Temperature Sensor (DS18B20-PAR+T&R)	2	4.51	9.02
Quad Output Op Amp (LM346N)	1	0.90	0.90
Black Tactile Switch (FSM4JH)	4	0.10	0.40
Red Tactile switch (1825910-7)	1	0.10	0.10

Rocker Switch Switch (RD221-MB-B-0-N)	1	1.61	1.61
GENS ACE 10000mAh 7.4V Lipo Battery (98P-40C-10000-2S2P-HardCase-Direct)	1	60.23	60.23

Section	Total
Labor	$38,250
Parts	$609.61
Total	**$38,859.61**

4.2 Schedule

Week	Task	Responsibility
2/4	Finalize and hand in proposal	Jon
	Mock DR sign-up	Cory
	Power Design Schematic	Harrison
2/11	Parts List	Cory
	Prepare Mock DR	Jon
	Circuit Simulation PSpice	Harrison
2/18	Finalize Electrical Design	Harrison
	Finalize Power Simulation	Cory
	Design Power Converters	Jon
2/25	Obtain Golf Bag and Create Refrigerated Pouch	Jon
	Consult Machine Shop About Solar Power Rack	Cory
	Begin Controller Design	Harrison
3/4	Test Peltier Modules	Jon
	LabVIEW Simulation of Temperature Control	
	Lay Out PCB Design	Harrison
	Design Digital Scorecard	Cory
3/11	Assemble and Test Solar Panels and Battery	Harrison
	Individual Progress Reports	Jon
	Program Control	Cory
3/18	**Spring Break**	**All**
3/25	Assemble Cooling System and Display and Test Control	Cory
	Integrate Outlet Power Conversion Component	Harrison
	USB Charger	Jon
	Prepare Mock-Up Presentation and Demo	
4/1	Overall Testing	Harrison
	Final Assembly	Jon
	Tolerance Analysis	Cory

4/8	Ensure Completion	Jon
	Fix Remaining Issues	Cory
	Verification of Specifications	Harrison
4/15	Prepare Paper	Jon
	Prepare Demo	Cory
	Prepare Presentation	Harrison
4/22	Paper	Jon
	Demo	Cory
	Presentation	Harrison
4/29	Return Supplies	Jon

5.0 Safety

As designers, it is our responsibility to provide a product that does not compromise the safety of its users when operated properly. Our project contains circuitry that drives potentially dangerous power levels. Therefore, these circuits will be isolated such that no components are exposed to the user. Similarly, our product may be used under non-ideal circumstances. While we encourage careful behavior, we understand that the product may be left outside for long periods of time or dropped. Our design must not be affected by weather or unintentional user error. Our design also involves thermoelectric cooling/heating modules. The modules operate by creating a temperature differential across the plates of the devices (up to 72^{o}C.) When running the temperature system at cold temperatures, the eternal plates will heat up. These plates cannot be exposed and the heat will be vented to avoid harm to the user.

When building our product, we must consider these hazards and apply our knowledge of lab safety procedures. It is the user's responsibility to understand the risks involved with improper use of this product. Altering circuit elements or reckless behavior can negate all safety provisions made by the designer.

6.0 References

"03111-5L31-03CG TEC Specifications." 03111-5L31-03CG. N.p., n.d. Web. 17 Feb. 2013.

"Arduino Digital Temperature Sensor Tutorial." Hacktronics. N.p., n.d. Web. 24 Feb. 2013.

"Arduino Due." Arduino. N.p., n.d. Web. 24 Feb. 2013.

Ardumania.es. N.p., n.d. Web.

Brain, Marshall. "How Microcontrollers Work." HowStuffWorks. N.p., n.d. Web. 10 Feb. 2013.

"GENS ACE 10000mAh 7.4V 40C HardCase Lipo Battery." GENS ACE 10000mAh 7.4V 40C HardCase Lipo Battery (Direct). N.p., n.d. Web. 10 Feb. 2013.

"How to Interface Graphics LCD with 8051 Microcontroller (AT89C52)." EngineersGarage. N.p., n.d. Web. 10 Feb. 2013.

"IEEE Code of Ethics." *IEEE - Advancing Technology for Humanity*. N.p., n.d. Web. 18 Feb. 2013.

Krein, Philip T. Elements of Power Electronics. New York: Oxford UP, 1998. Print.

Ladyada. "Character LCDs for Use with Arduino." Adafruit Learning System. N.p., n.d. Web. 24 Feb. 2013.

"NHD-0208BZ-FSW-GBW-33V3." Digikey.com. N.p., n.d. Web.

"NHD-0420H1Z-FSW-GBW-33V3." *Digikey.com*. N.p., n.d. Web.

"StarTech USBMBADAPT Spec Sheet." StarTech.com. N.p., n.d. Web. 17 Feb. 2013.