April 16, 2014
Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, BC, V5A 1S6

Re: ENSC 440 Design Specification for an Advanced Function Maximum Power Point Tracking Battery Charger for 12 Volt Lead-Acid and 16 Volt Ni-Cad Batteries

Dear Professor Rawicz:

The attached document is the post mortem for an Advanced Function Solar Power Batter Charger for 12 Volt Lead-Acid and 16 Volt Ni-Cad Batteries proposed by Solar Solutions. Our product, Helios MK-I allows the user to efficiently charge a battery using a solar panel as a power source by implementing an MPPT algorithm.

The purpose of the post mortem is to outline the current state and the future plans for our device. Additionally, the document addresses remediation's put into place during the course of the semester due to time constraint. Lastly, this document contains interpersonal and technical experiences gained throughout the full semester.

Solar Solutions consists of five members and is receiving funding from Analytic Systems, which is North America's fastest growing power conversion company. You may contact me by phone at 604-761-4568 or by email at rhargrov@sfu.ca if you have any concerns or questions about our proposal.

Sincerely,

Richard Hargrove

Richard Hargrove
President and CEO
Solar Solutions

Enclosure: *Post-Mortem for an Advanced Function Maximum Power Point Tracking Battery Charger for 12 Volt Lead-Acid and 16 Volt Ni-Cad Batteries*

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Post-Mortem for an Advanced Function Maximum Power Point Tracking Battery Charger for 12 Volt Lead-Acid and 16 Volt Ni-Cad Batteries

ENSC 440: Capstone Project, ENSC 305: Project Documentation

Project Team: *Sam Chow*
Richard Hargrove
Sulki Hong
SamanHoshyar
Filip Zivkovic
Sponsors: *Analytic Systems, Delta*
(604) 946-9981
Proposal Date: *April 16 , 2014*
Panel: *Dr. Andrew Rawicz*
Steve Whitmore

Revision: *1.4*

Contents

Table of Figures

Acronyms

A	amperes
A/D	analog-to-digital
DC	direct current
EMI	electromagnetic interference
HM1	Helios Mk-I
IDE	integrated development environment
LED	light-emitting diode
MPPT	Maximum Power Point Tracking
NiCd	nickel cadmium
PbA	lead acid
PCB	printed circuit board
PIC	peripheral interface controller
PID	proportional integral derivative
PWM	pulse-width modulated
SFU	Simon Fraser University

1.0 Introduction

The content of this document outlines the current state and future plans for HM1 as well as to share the technical and interpersonal experiences of the individual members. During this semester, Richard Hargrove, Saman Hoshyar, Sulki Hong, Filip Zikovic and Samuel Chow designed and developed the project. Helios Mk-I (HM1) is a solar panel battery charger that implements a maximum power point tracking (MPPT) algorithm to optimize power transfer from solar panels to a battery and load. The specification for this project was given to Solar Solutions by Analytics Systems as per request from a customer. HM1 will be a standalone product to power a radio repeater on remote mountain tops around British Columbia. Overall, HM1 will be capable of charging a 12V PbA and 16V NiCd batteries, but can easily be extended to other batteries. HM1 is part of the renewable resources technology sector, and takes part in creating a sustainable future.

2.0 Present State and Remediation

As in the Project Proposal, HM1 is a solar panel battery charger that implements a maximum power point tracking (MPPT) algorithm to optimize power transfer from solar panels to a load. It is projected to be capable of charging 12V PbA and 16V NiCd batteries. Our high level system overview block diagram is illustrated in Figure 1. Notice that Figure 1 displays the relationship between the subsystems, the inputs and the outputs.

The system inputs and outputs that are currently implemented are the solar panel input, current and temperature sensors, battery output, and load output. Although we have implemented the hardware for RS 232 communication, time restraints prevented us from completing the firmware aspect to the reader. We did however achieve an on/off switch. We focused on hardware design as the priority, since it is more difficult to modify in future revisions.

The signal processing stage consists of the microcontroller and data-measurement circuits. Utilizing the microcontroller, analog-to-digital measurements are converted, pulse width modulation drives the switching, MPPT is overlaid in parallel to current limit control, and preceding a PID control loop for modifying the duty cycle. Protection for the battery, load, solar panel, and microcontroller are implemented. They were determined to be functional, as we burned a few fuses and zener diodes during testing. Fortunately, this was all easy to replace

Gate drivers will receive the pulse width modulation that drives the switches to run the converter. The LEDs were implemented to give visual feedback to the users. LEDs provide user feedback to determine whether the device is working as desired.

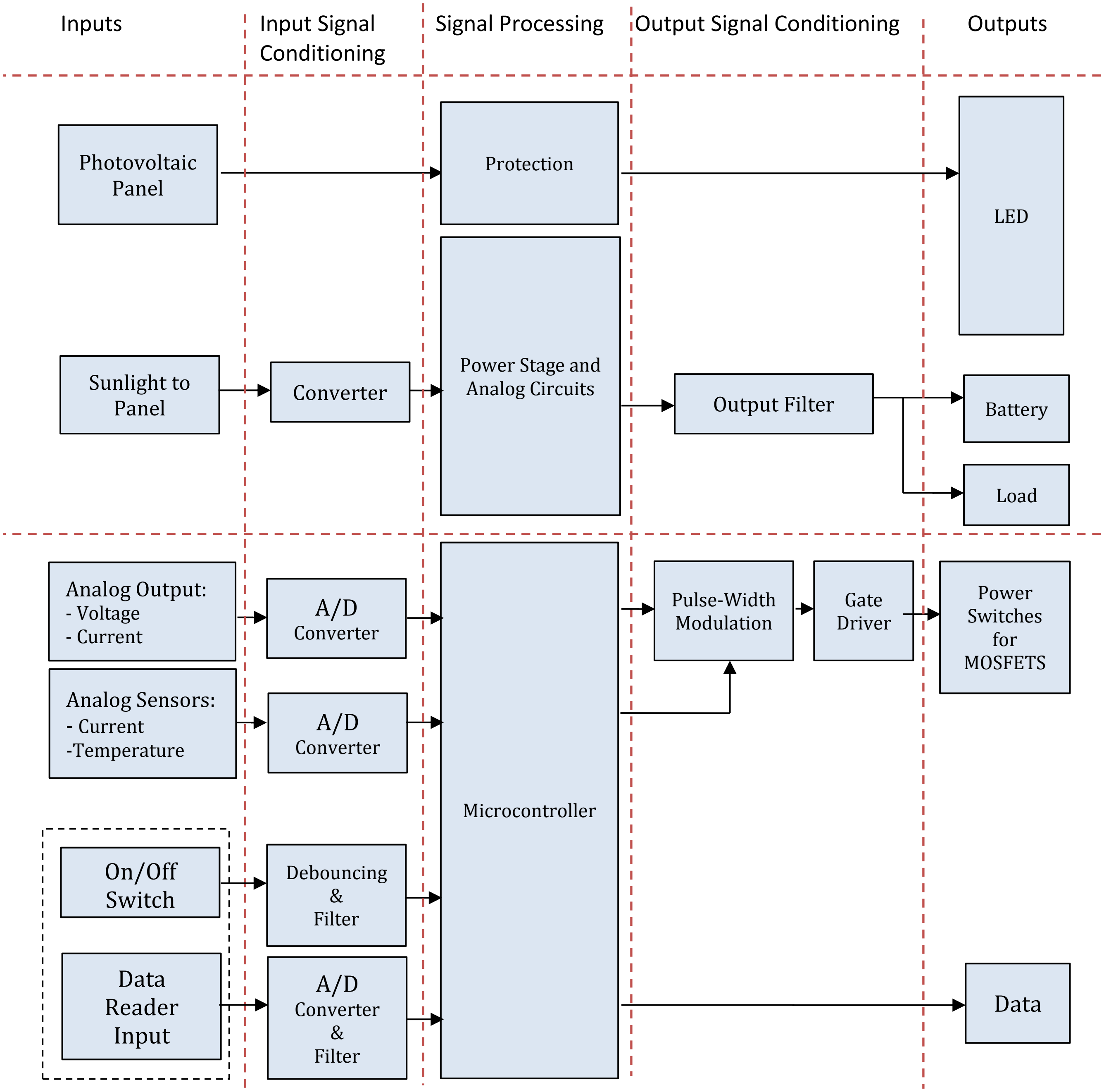

Figure 1: High Level System Overview of HM1

The present state of the hardware is complete and functional. We have two complete boards. On the next page is a photo of one of these boards.

Figure 2: Fully functional buck/boost converter created by Solar Solutions

The present state of the firmware is also functional, but not complete to industry level standards. It was satisfactory for our demo, and for complete testing of the hardware. What is missing is that the response time does not quickly respond to changes in the load or input voltage. Below is a more advanced diagram of how the firmware would actually be completed if we were to sell to industry, followed by the implemented firmware algorithm currently used.

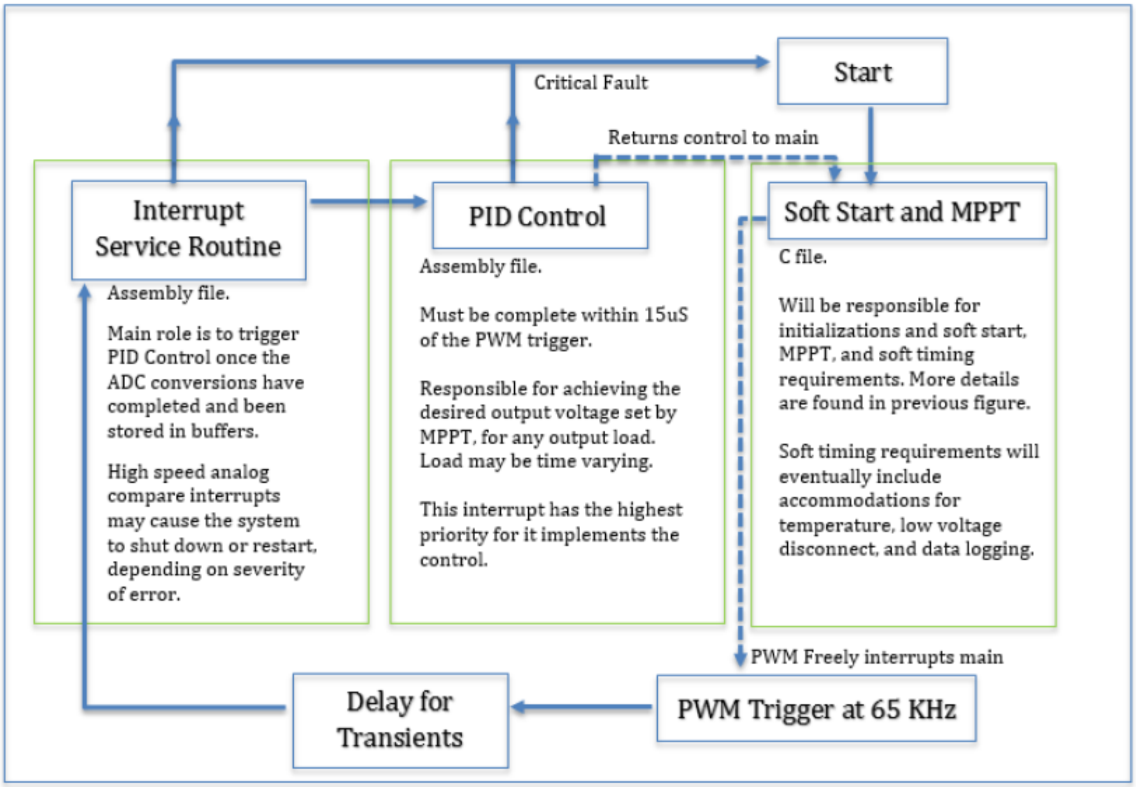

Figure 3: Low response time firmware, which was attempted but not implemented successfully.

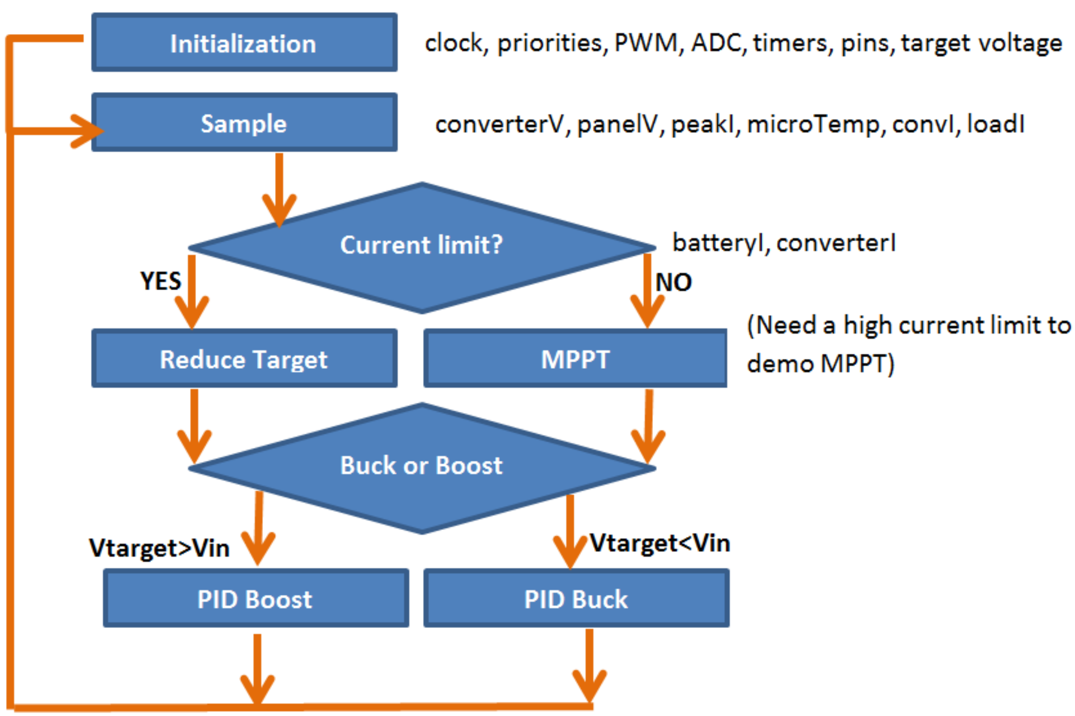

Figure 4: Implemented firmware by Solar Solutions.

A similar such block diagram exists for the MPPT, both completed and optimal. I have included these in the Appendix, for enthusiastic readers.

3.0 Future Plans

Further research and improvements can be completed on our first model. A majority of future work will be focused on developing firmware, and streamlining the production process would occur later on. Future plans consist of additional testing for overall robustness of our product. The future plan for HM1 is listed below.

1. Implement a more advanced MPPT
2. Synchronous switching, which means turning on the low side MOSFETs instead of using the diodes.
3. Complete coding of serial communication to microprocessor using Visual Basics
4. Implementing RS-232 communication link with flash memory
5. Additional revision on the PCB
6. HM1 to be functioning within wide ranges of solar panels
7. Complete tests for safety, reliability, efficiency and correctness of numerical values as stated on datasheets
8. Additional tests in the temperature chamber, and temperature adjustments
9. Additional characterization of efficiency within the operating region
10. Additional EMI level testing within an EMI chamber
11. Outdoor testing to monitor efficiency of MPPT's effectiveness
12. Potential cost reduction for redundant components or parts after additional revision
13. Additional tests for components and parts of schematic as listed below
    A. Inductor: efficiency of energy conversion
    B. Auxiliary power supplies: Ensure it supplies enough power to the active components
    C. Current sensors are accurate with little variance
    D. Tested TVS breakdown voltages
    E. Fully tested fuse
    F. Fully tested Crowbar

4.0 Financial

Table 1 outlines the projected budget and actual cost of the project.

Table 1: Estimated Cost vs. Actual Cost

Item #	Estimated Cost	Actual Cost
Components for Prototype #1	$500	$1400
PCB Prototype #1	$500	$1400 (rapid prototyping)
Chassis	Borrowed	Borrowed
Components for Prototype #2	$500	N/A
PCB Prototype #2	$500	N/A
Total	$2200	$2800

Contracted by Analytic Systems to design HM1, Solar Solutions had approximately $2500 for the project for an estimated cost of $2200. However, with Analytic Systems' approval, we decided only to go with a single PCB revision only to provide Simon Fraser University with a piece of demonstrable hardware for our Capstone project due to a time constraint. Due to time constraints, even this single prototype turned out to be more expensive than we anticipated. The actual cost of the project of $2800, and was strongly raised by the 'rush' placed on the PCB order.

5.0 Time Constraint

Throughout the project, the deadlines were greatly underestimated. The initial deadlines outlined in Gantt chart presented in the project proposal were strongly abandoned, since they were unrealistically ambitious. Nevertheless, we completed all of the revised goals. Original underestimations were rampant amongst the team members, since the complexity of tasks was overlooked during the initial stages of the project.

The revised goals removed heavy firmware emphasis. The firmware still demonstrated MPPT, and still completed the current loop and buck/boost measurements. There was very little time or motive to go overboard with advanced firmware.

Despite the underestimation, we were able to complete the schematic design and the PCB layouts before April. Because of the original under-estimations, and due to the difficulty of our project, we had to work excessive hours during the final few weeks to ensure completion. Consensus amongst the group members was that we would work as hard as possible to meet our ambitious project requirements, and we are happy we managed to succeed within the time constraints we gave ourselves.

6.0 Group Dynamics

The team was organized as such:

Richard Hargrove, Chief Executive Officer
Saman Hoshyar, Chief Technical Officer
Samuel Chow, Chief Operating Officer
Sulki Hong, Vice President of Software Engineering
Filip Zikovic, Vice President of Firmware Engineering

To summarize, many of the difficulties within the group dynamics were a result of design methodology utilized in power electronics. The development of the project was "serial", as in step-by-step. There were very few cases when people could work on separate tasks and then integrate their work. All future steps were based on recent results. Throughout the entire semester, the group dynamics were strongly challenged, because we had to work together on almost all aspects of the project. Teamwork is sometimes not practical.

Each individual was assigned tasks throughout the semester, based on qualifications and need. Richard, Sam, and Saman were mainly in charge of schematic design, with Richard being the lead engineer. This was a good match for each of their skills. Sulki and Filip worked to understand the hardware designs, and planned ahead to develop the firmware and algorithms. Sulki further assisted as the main technical writer throughout the project. Filip continued to work on the firmware, and eventually achieved MPPT, after receiving helpful tips from Saman and code review from Sam. Every individual took the initiatives to ensure that they were learning materials and providing feedback when they had the qualified skills to do so.

There were occasional disagreements, especially when firmware was struggling and there was limited board resources. Each team member would make suggestions; however, there was a strong limit to the time allotted for firmware development. Many potential suggestions were discarded or revisited based on need. One example is that Saman wanted to perform the MPPT by directly modifying the duty cycle, but Filip disagreed because this would sacrifice the control. Without working code, it was difficult to justify which approach was most suitable, especially since both were possible.

There were occasional disagreements as to "what the next development steps" to be taken should be. Proceeding the soldering of the auxiliary power supplies and microcontroller, it was not clear as to what the next step should be. Sometimes there were disagreements between Richard and Saman, stating that group members may be wasting their time.

At other times, Filip would ask Sam to check over his work and algorithm, so as to help in debugging. However, Filip did not provide Sam with enough time to overlook his work appropriately, and was rather inpatient. With only one board between the two members, it was difficult to share.

In all occasions, debates were shortly resolved and properly articulated for members to come to a quick and efficient consensus.

7.0 Interpersonal and Technical Experience

7.1 Workload Distribution Chart

Below is the workload distribution chart. Note that not all sections are necessarily weighted equally. For example, hardware is a more significant burden than mechanical. Most importantly, each member contributed the maximum that they were capable of within their given workload and technical expertise.

Table 2 Workload distribution chart for Solar Solutions

Project Category	Richard Hargrove	Samuel Chow	Saman Hoshyar	Sulki Hong	Filip Zivkovic
Mechanical	9	10	N/A	N/A	N/A
Assembly	10	10	9	7	7
Testing	10	10	10	7	8
Hardware	10+	9	9	7	7
Firmware	10	7	7	7	10
Technical Documentation	9	9	7	10	10

Richard received a “10+” on hardware because he went beyond his section which was of great difficulty.

7.2 Individual Learning—Richard Hargrove

During ENSC 440 and ENSC 305 I have gained many valuable skills to help my career begin. This is my second project I have been heavily involved in from conception to prototype and this project was significantly more complicated and furthered my knowledge in many different areas.

I was already an adept user of LTspice but this project reinforced my simulation skills and I utilized them heavily. The most significant simulation achievement was to simulate a LT part in a use not described in an app note and carry that design over to a real TI part that also did not include any app note regarding the specific function. This felt like a huge achievement when it worked.

I also gained large amounts of experience using Altium. I had previously done a complete schematic and PCB design in Altium for a small project but the magnitude of order in complexity and the sheer number of components that needed to be added to Altium took my skills to a whole new level. Unfortunately I did not have as much time as I would have hoped in order to complete the Schematics and PCB. There was evidence of rush on the PCB, which could have better utilized space.

I had previously wrote firmware in MPLAB 8 for a 16 pin PIC16 microcontroller as part of another project so I was very comfortable in the transition to MPLABX and the much larger 64 pin top of the line microcontroller (chosen to sync up with Analytic Systems' designs). I learned a lot but had a major disappointment in the end result. We attempted to implement a dual current and voltage PID for cycle by cycle current limiting and accurate voltage outputs but we did not have the time to troubleshoot it.

I have extensive experience testing and troubleshooting electronics in a lab so I was able to quickly and efficiently solve all hardware problems encountered. Every tested aspect of our design works well and everything that did not work when originally tested has been fixed.

Aside from technical skills I also have become more adept at team management, conflict resolution and scheduling. I was constantly giving out tasks and deadlines and they became progressively more realistic as the semester went on. Disputes and disagreements on problem solving methods were also handled successfully and there were very few conflicts near the end of the design phase.

During the semester I have reinforced and added to the skills I already considered my assets. The improvement in my skills has been tremendous and I am excited to apply my new skills in industry this summer.

7.3 Individual Learning—Saman Hoshyar

I learned several important skills throughout the design of our ESNC project. One of the most important lessons I learned was to rely on existing technology as much as possible. While at the top level it might be important to innovate, at the lower levels it might be best to use proven and tested technologies. I spent a lot of time trying to build discrete gate drive circuits and current protection schemes. While most of these circuits worked, and some even worked very well, I came to learn none of them approached the performance of discrete IC solutions offered by several vendors.

Another important lesson I learned was about overall power supply topologies and power electronics. I am proud to say that I am leaving this project with a new appreciation of power supply design. This projected has helped me cement my career goals. Power electronics is now what I want to learn more about and the field that I think I will be spending the rest of my life in.

Throughout this project a great deal of arguments were had between teammates, however I am proud to say that our group is leaving ENSC 440 on much more endearing terms than we entered it. I think I speak for everyone when I say that the methods we used to remediate our disagreements worked out very well. We all did our very best to stay friendly and helpful with one another even during our most challenging periods.

Another lesson that I took away from this project was debugging problems. One of my main duties was isolate problems and tackle them from the path of least resistance. I used this method to successfully devise a method to handle MPPT which was very easy to implement during the very tight time period we had to work in.

I'm a very casual worker, I don't like to work under stress and I like to take my time. Being forced to race against time (and the weather/time of day when implementing MPPT and working with the solar panels) forced me to break out of my casual habits and work really hard under great pressure, I think this is one of the lessons that will stay with me for the rest of my life. Next time I am forced into meeting a tight deadline I will be sure to think back to this moment and know that I have it in me to perform well under great pressure.

7.4 Individual Learning—Samuel Chow

This project for ENSC 440 has contributed to my engineering education at SFU greatly. I felt like a real engineer working on this project. Having little to no knowledge on power supplies and having only 4 months, I was able to learn quickly, efficiently, in a team and partition my time in a sensible manner. This learning experience helped me secure an 8 month intern at Schneiders working on the largest solar farm in the world to this date.

Hard skills I have learnt incorporate the in depth use of software such as LT spice to simulate our designs. This was very important as it helped us figure out what parts worked and what didn't, and helped us figure out cheaper parts that could be used. I had the chance to use Solid Works to design 3D models for our PCB and size parts to make sure they would fit in our chassis. I used Altium to help design the PCB; laid out components, and drew schematics. For firmware we used MPLABX which I had a chance to write a bit of C in, learning different algorithms to implement for the MPPT. All these tools are industry standard programs that are used consistently and it is fortunate I had the chance to use them. Aside from using programs, I learnt how to strategically pick parts for their capabilities and pricing. I hand wound inductors, sizing them to the correct inductance that was used in our design. I remodeled our chassis in the machine shop to fit our PCB (Our PCB was slightly too small). I also had to chance to use my lab skills to test Helios.

My soft skills include working with my team, through the highs and the lows. There were disagreements but I was able to hold healthy debates and work towards solution and the ultimate goal. Being punctual and meeting time lines were important, this incorporated multitasking and time management as I was taking multiple courses. Having the ability to learn and understand concepts fully. This was not a course I was taking where there was material that I was being tested on. The test was on actually building a working battery charger. It was fundamental to learn all the concepts like how buck-boost works, PWM, setting duty cycles, MPPT, PCB design and much more. Finally, I learnt to always plan for contingencies.

Overall, there was a copious amount of skills learnt in these past 4 months. Some skills I already had and refined while many were brand new and learnt on the job. These skills have landed me a co-op working at Schneider Electrics who are designing the largest solar farm in the world.

7.5 Individual Learning—Sulki Hong

Throughout the whole semester, I have gained invaluable experience by assisting in the power supply design. I am confident that I have assisted my colleagues whenever they needed. Although my overall knowledge of the design of power supply can still improve, I am confident that with enough experience and opportunity, I will continue to advance my hardware skills. By being a part of this group, I became more knowledgeable of non-inverting buck and boost topologies, and learn to apply tools such as LT spice to test different functionalities to ensure that some circuits perform the way we wanted to. Additionally, I have gained an insight of the iterative design process. One important aspect of design process that I learned this semester is that plans do not always workout accordingly. Thus having a plan B was essential to ensure that we do not rush at the end and have a still demonstrable product for demonstration.

Throughout the semester, I've noticed that developing a product requires us to begin building, rather than spend excessive time researching. Once we begin building, we become familiar with the issues we need to solve, and then all further research is far more productive. This realization is very important and applicable to all of my future projects, and significantly reduces development time.

Furthermore, I've gained invaluable experience as a technical writer by assisting and drafting various documents required for this course.

I've gained understanding of group dynamics throughout the whole semester. Although all group members were friends prior to this semester, I've noticed that we did run into occasional trouble once in a while. When this arises, I've learned that understanding and listening to others worked the best. Similarly, I've learned to trust and be patient and be respectful amongst team members.

Aside from practical knowledge and experience, I have learned to be a professional. By observing other team members, I have learned that being a professional incorporates the following traits: Passionate, hardworking, interested, enthusiastic, result-oriented, responsible, open-minded, helpful, committed, proactive, respectful, knowledgeable, eager, innovative and detailed oriented. By emulating my fellow colleagues, I have gained a general understanding and expectations about being a professional. By partaking in this project, I have gained an invaluable experience as I am preparing to graduate. I can confidently say that this project have provided a firm stepping stone for a future endeavors as an engineer and new insight into a different field that I had previously did not consider

7.6 Individual Learning—Filip Zivkovic

My strongest skills from the project were in firmware development, which required me to understand the entire product and its operation.

The firmware development had many timing constraints to meet. The clock of the microcontroller and the auxiliary clock were the two driving forces for firmware. To change the clock frequency, would mean to restart the project almost. Although my main task was programming, my enthusiasm and interest for hardware allowed for me to pick up on other members work. This was important, since to program the converter so as to meet timing constraints or perform as desired, I had to know the hardware extremely well. Consistently when there were errors, it would be a hardware error, firmware, or a mixture of the two. Learning to debug such systems was a new skill. I learned techniques such as saving data in arrays for analysis, which is necessary since halting the program doesn't allow for runtime analysis.

I was introduced to soldering surface mount components, and the steps I should follow in future projects if I design my own hardware. I learned how to write snippets of firmware for testing hardware, which documents to reference, and to use tools such as an active load, heat gun, and more, when quantifying the behavior of our device. If I were to attempt my own smaller scale project, I would know what steps to take.

I learned the importance of technical documentation during development. Documentation is useful to ensure the entire team is in agreement, serving as a reference tool, and as a quick illustrative tool within future presentations. Keeping a journal helped promote good habits, and reduced the loss of work. I learned the importance of project proposals, functional specifications, and design specifications within a project.

Most importantly, I gained exposure and confidence in developing an industry level product. Helios MK-I is marketable, and performs exceptionally well. Cost tradeoffs, ordering parts and PCB's, and the entire design process I am now familiar with.

8.0 Conclusion

Helios MK-1 is a 300 Watt DC/DC converter completed by Solar Solutions as part of our ENSC 440/ENSC 305 credits at Simon Fraser University. MK1 completes maximum power point tracking to maximize the input solar power to the converter. The output has current limiting so as not to overcurrent the battery on the output, and there is a parallel output for powering a load from the converter or from the battery. All system parameters are easily tunable within the firmware, such as the output voltage, MPPT algorithm, and current limit. No multistage charging algorithm or cycle-by-cycle control were implemented within the firmware due to the scope of the project.

Protection circuitry is in place to help prevent users from damaging other equipment or hurting themselves. Additional hardware is in place that is not yet implemented by the firmware, in anticipation for Analytic Systems to be able to continue the project and use this hardware. Such hardware includes the synchronous MOSFETs for the low side gate drive, temperature sensors, and the RS 232 communication port. The hardware design was largely completed by the CEO, Richard Hargrove. Richard attended a Ray Ridely workshop to gain the valuable experience he needed in designing buck-boost converters, because he anticipated the difficulty of the hardware design well in advance.

The end result has been a successful investment for Analytic Systems, and a semester in which our team exhibited documentation and design skills to complete a competitive product.

Solar Solutions

AGENDA

Date: April 15/14
Time: 3:00 pm
~~Sunny Room~~ Analytic Solution

Purpose of Meeting: Final Meeting
Items for Discussion:

A How we want to do our demo and presentation

MINUTES

Date: April 15/14
Time 3:00pm
~~Sunny Room~~ Analytic Solution

Present: All
Absent:

Purpose of Meeting: Presentation / demo

Minutes:

A. Approval of the agenda and minutes of the ~~January 5, 2006 meeting~~ ~~Jan~~ April 15/14.

B. Business Arising

WHO is doing what during presentation

Discussion: food ?

Action: Richard doughnut, filip & sulki ⇒ cups / plates snack

C. ~~Is brick a better alternative for house construction than wood?~~

Discussion: what we need for demo / presentation

Action: scope DMM, battery, panel, oscilloscope old magnetics (induct

D. Next Meeting Date

Never

E. Other Business

NA

Solar Solutions

AGENDA

Date: Dec 27/2013
Time: 4-30pm
Richard's house

Purpose of Meeting: Go our overall objectives for project.
Items for Discussion:

* which roles will individual team member will partake
* scheduling time
* funding method ~~fr~~ group communications

Solar Solutions

MINUTES

Date: Dec 27/2013
Time 4:30pm
Richard's house.

Present: Everyone
Absent:

Purpose of Meeting:
go over objectives for project

Minutes:

A. **Approval of the agenda and minutes of the** Dec 27/2013 **meeting**

B. **Business Arising**

Discussion:
how do we communicate?
look at everyone's schedule to find a mutual time.

Action:
facebook group chat
Tuesdays from 12:30 — 2:30 or approximately

D. **Next Meeting Date**
January 7th, 2014.

E. **Other Business**
N/A.

Solar Solutions

AGENDA

Date: January ~~6th~~ 6th.
Time: 6pm

Purpose of Meeting: Discuss circuit complexity.
Items for Discussion: Topology choices for all ~~subcircuits.~~ subcircuits.

Solar Solutions

MINUTES

Date: monday Jun ~~6~~th.
Time ~~6~~PM

Present: All
Absent: N/A

Purpose of Meeting: Discuss topology of Converter, Set up possible Realistic goals. wants/needs; Resonant, soft switch / Hard switching, linear Regulator VS Switching Aux Supplies

Minutes:

A. **Approval of the agenda and minutes of the** monday Jun 7th. **meeting**
given by Richard

B. **Business Arising**

Discussion: level of Sophistication ~~required~~ Wanted, "How Fang is our circuit"

Action: - Decided Against Complicated switching form, but opted for SMPS for Aux circuits.

D. **Next Meeting Date**
Jun 14th.

E. **Other Business**

—

Solar Solutions

AGENDA

Date: Jan 11th.
Time: 5:00

Purpose of Meeting: Power Stage.
Items for Discussion: — Quote Phase / MOSFET /

Solar Solutions

MINUTES

Date: Jan 4th
Time 3:00

Present: All
Absent:

Purpose of Meeting: Switching power stage discussion

Minutes:

A. **Approval of the agenda and minutes of the** Jan 4th **meeting**
Given by Roshan

B. **Business Arising**

Discussion: Gate Drivers (continuous Drive? PMOS? NMOS? Isolated?) ~~Re~~ Synchronous switching?

Action: ~~Have Gtor~~ Choose Isolated gate Drive, for continuous Drive capabilities, NMOS, ~~iso~~ Synchronous would be nice.

D. **Next Meeting Date**
Jan 19th

E. **Other Business**
Spoke in general about MPPT Algorithms, parallel control Algorithms

Solar Solutions

MINUTES

Date: Jan. 19th.
Time 2:30 PM.

Present: Sam, Sulhi, Richard, Filip
Absent: Suman

Purpose of Meeting: Pick Topology.

Minutes:

A. **Approval of the agenda and minutes of the** Jan. 19th, 2:30pm **meeting** ~~Appr give~~ given by Richard.

B. **Business Arising**

Discussion: — Pick Topology.

Action: — decided against Topologies w/ Transformers. Bunthing too complicated. Buck-Boost non-inverting ~~was~~ was chosen As it met specs and Did not present technical hurdles other topologies did.

D. **Next Meeting Date**

Jan 25, Saturday

E. **Other Business**

Solar Solutions

AGENDA

Date: Jan 16th
Time: 2:30pm

Purpose of Meeting: Pick topology, talk About complexity of circuit.
Items for Discussion:

- Transformers?
- Buck-Boost.
- Other topologies.

Solar Solutions

MINUTES

Date: feb 4th
Time 1:30pm

Present: All
Absent: non.

Purpose of Meeting: discuss firmware.

Minutes:

A. Approval of the agenda and minutes of the 11th feb, [illegible] **meeting**

B. Business Arising

Discussion: which microprocessor to use & who is incharge of the firmware.

Action: use A dspic33F series microprocessor
– filip & Richard Are in charge of the firmware.

D. Next Meeting Date 11th Thursday.

E. Other Business —

Solar Solutions

AGENDA

Date: feb 4th
Time: ~~1~~:30pm

Purpose of Meeting: Discuss firmware
Items for Discussion: ~~firmware~~ chip) Breakdown of work
CPU

Solar Solutions

MINUTES

Date: 11th febru
Time 1:30pm

Present: All ~~[illegible]~~
Absent: —

Purpose of Meeting: Layout meeting.

Minutes:

A. **Approval of the agenda and minutes of the** 11th febru **meeting**

B. **Business Arising**

Discussion: laying out power circuit.

Action: Went over synchronous mosfets/mosfet selection/Diode Selection/Inductor size /cap size set size.

D. **Next Meeting Date**

feb. 20th

E. **Other Business**

—

Solar Solutions

AGENDA

Date: 11th feburary.
Time: 11:30pm

Purpose of Meeting: circuit layout
Items for Discussion: ~~contime~~ Layout circuit.

Solar Solutions

MINUTES

Date: Feb 20th
Time 1:30pm.

Present: All
Absent: —

Purpose of Meeting: Disuss safetyplan.

Minutes:

A. Approval of the agenda and minutes of the feb 20th meeting **meeting**

B. Business Arising

Discussion: talked about some saftey designs we can implement in our system.

Action: — we implemented, output short circuit, input diode protection, overvoltage protection. & over temperature

D. Next Meeting Date feb 23rd

E. Other Business —

Solar Solutions

AGENDA

Date: Feb 20th
Time: 1:30pm

Purpose of Meeting: – plan out safety for Board.
Items for Discussion:
– Circuit Breakers / Fuses

Solar Solutions

MINUTES

Date: feb 22r
Time 1:3w
Sunny Room

Present: All
Absent: noue

Purpose of Meeting: taha about gatutue.

Minutes:

feb 2rd

A. Approval of the agenda and minutes of the [redacted]eting

B. Business Arising

Discussion: pick gak arler chip.

Action:

C. ~~Is brick a better alternative for house construction than wood?~~

Discussion: pick farms 7905.

Action:

D. Next Meeting Date march 1st.

E. Other Business

Solar Solutions

AGENDA

Date: feb 23rd.
Time: 1:30.
Sunny Room

Purpose of Meeting: Talk about ~~[illegible]~~ gate drive
Items for Discussion:
pich chip.

Solar Solutions

MINUTES

Date: march 4th.
Time 1:30
Sunny Room

Present: All
Absent: none

Purpose of Meeting:

Minutes:

march 4th.

A. **Approval of the agenda and minutes of the [redacted] meeting**

B. **Business Arising**

— heatsinking chassis design.

Discussion:

Action: (How can we thermally get rid of heat ?

~~C. Is brick a better alternative for house construction than wood?~~

→ We need to first find
The total power dessipated
→ decide
if we need
heatsinks for [illegible]?

Discussion: (

Action: How Big is the chasis?
↳ How much power
Can it dessipate?

D. **Next Meeting Date**

11th.

E. **Other Business**

Solar Solutions

AGENDA

Date: march 4th.
Time: 1:30.
Sunny Room

Purpose of Meeting: Thermal consideration
Items for Discussion: heatsinking, vias.

Solar Solutions

MINUTES

Date: march 11th.
Time 11:30

Present: All - ~~R~~Richard.
Absent: - Richard (Birthday)

Purpose of Meeting:

Minutes:

~~[illegible]~~ 11:30.

A. Approval of the agenda and minutes of the ~~January 5, 2006~~ meeting

B. Business Arising pick out chasis / Board size.

Discussion: size?

Action:

C. ~~Is brick a better alternative for house construction than wood?~~

Discussion: 12 inches x 6 inches PCB.

Action: Aluminium. 1 Pound Can.

D. Next Meeting Date 18th. mar.

E. Other Business

Solar Solutions

AGENDA

Date: March 11th.
Time: 11:30

Purpose of Meeting: finish of mechanical work.
Items for Discussion:
— board size, chasis shape.

Solar Solutions

MINUTES

Date: march 18
Time 1:30.
Sunny Room

Present: All
Absent: nw

Purpose of Meeting: firmwa

Minutes:

A. Approval of the agenda and minutes of the march 11th [redacted] **meeting**

B. Business Arising firmwe

Discussion: firmware.

Action:

C. ~~Is brick a better alternative for house construction than wood?~~

Discussion: Started implementing coding standards to ~~go~~ handle multiple people working on firmware.

Action:

D. Next Meeting Date march 25th.

E. Other Business Y

Solar Solutions

AGENDA

Date: march 19
Time: 1.30.
Sunny Room

Purpose of Meeting: firmware.
Items for Discussion: How to handle firmware.

Solar Solutions

MINUTES

Date: march 25th.
Time 11:30 Am
Sunny Room

Present: All
Absent: none.

Purpose of Meeting: mppt.

Minutes:

march 25th

A. Approval of the agenda and minutes of the ~~January 5, 2006~~ meeting

B. Business Arising

Discussion:

Action: Discussed How mppt was going to Be implemented.

~~**C. Is brick a better alternative for house construction than wood?**~~

Discussion: Vary duty cycle → observed distortion

~~**Action:**~~ perturb / → Reduce if ince

→ perturb & observe.

D. Next Meeting Date

March 29th

E. Other Business

Solar Solutions

AGENDA

Date: march 25!
Time: ~~march 25th~~ . 11:30 .
Sunny Room

Purpose of Meeting: discuss mpt.
Items for Discussion:

Solar Solutions

MINUTES

Date: march 29th.
Time 11:30
Sunny Room

Present: All
Absent: m -

Purpose of Meeting:

Minutes: PCB Trouble.

A. **Approval of the agenda and minutes of the ~~January 5, 2006~~ march 29th meeting**

B. **Business Arising**

Discussion: PCB does not fit in ~~B~~ ~~box~~ chassis.

Action:

~~C. Is brick a better alternative for house construction than wood?~~

Discussion: — Drill out chassis.

Action:

D. **Next Meeting Date** April 3rd.

E. **Other Business**

Solar Solutions

AGENDA

Date: march 29th
Time: 11.30
Sunny Room

Purpose of Meeting: discuss troubles w/ PCB
Items for Discussion: Layout issues.

Solar Solutions

MINUTES

April 3rd

Date:
Time ~~April 3rd~~. 1:30 PM.
~~Sunny Room~~
Anylitic System.

Present:
Absent:

Purpose of Meeting: ~~No~~ Catchy.

Minutes:

April 3rd.

A. Approval of the agenda and minutes of the ~~January 5, 2006~~ meeting

B. Business Arising

Discussion: talked About How the cirout Assembly is comming

Action:

C. ~~Is brick a better alternative for house construction than wood?~~

Discussion: - contined Assembly.

Action:

D. Next Meeting Date April 5th.

E. Other Business ~