High Current Pulse Generator for the Application of Transcranial Magnetic Stimulation

Clients/ Advisors: Priyam Rastogi, Neelam Gaunkar, Jayaprakash Selvaraj, Dr. Mani Mina

Project Objective: Over the course of 2 semesters, design, fabricate, and test a high-current pulse generation device for use in TMS research.

Team Members:

Brian Kirkpatrick: Head of Circuit Design
Jon Rothfus: Head of Micro-Controllers, Team Communications Leader, Webmaster
Tania Alvarado Carias: Head of Electrical Safety
Abdul Bahashawn: Head of Rectification Circuits
Yan Wang: Head of Component Selection
Curtis Richards: Team Leader

Sub Teams:

Chassis Design: Tania, Curtis, Yan	-Meets Thursdays 2:00-2:30 p.m. Howe
Rectification Circuit: Abdul, Yan, Brian	-Meets Fridays 11:30-12:00 p.m. Marston
Power Circuit: Tania, Curtis, Abdul	-Meets Fridays 2:00-2:30 p.m. TLA
Micro Controller: Jon, Brian	-Meets Wednesdays 1:15 - 1:45 in TLA

Weekly Summary:

- Power Circuit:

    Power Circuit team met and discussed several different switching component options. We also investigated as to how we will purchase parts in the future with the shop. First we will look on Digikey and Newark for a part, and if it is not found there we will be able to request it from another place.

- Chassis Design:

    Discussed what material was going to be used as a container. Split the research up to three options which were plastic, wood, and metal.

- Micro-Controller (M.C.):

Decided on Arduino w/Arduino web IDE and Matlab as the toolchain for microcontroller control portion of project. Installed Matlab and Arduino support packages and tested Matlab connection with Arduino. Connection OK.

- Rectification Circuit:

Rectification circuit team met and discussed the different possible options for center tap transformer between buck converter, switch mode power supply, single-ended primary-inductor converter (SEPIC). We are meeting this week to discuss and decide which option to choose given factors, such as cost and performance for our design based on assigned individual research. We also talked more about the EAGLE PCB Builder software for simulations.

Accomplishments of the Past Week:

Each member is to write up a reflection on their work throughout the week. The reflections can be found at https://iastate.app.box.com/folder/46145323949
Brian
Jon
Tania
Abdul
Yan
Curtis

Pending Issues:

As a team with the client, we need to better define the requirements of this project and develop a timeline of the deliverables. Below are the current objectives we have:

- Objective of Circuit
    Peak Current of 2 KA +10%
        EMF feedback must be considered
    Peak Current Sustained for 400 μs
    Rise/fall time of 100 μs
    Up to 36 Hz pulse frequency (Commercial Benchmark)
    Circuit Input- 120 V wall outlet.
    Range of Load - 5 micro-Henry (min) to Max(Undefined)
    10 pulses a minute
    Biphasic
    The machine shall output multiple waveforms (Square, Sawtooth, etc.)

Business:

I.   GitHub will no longer be used, we will default to Google Drive for keeping track of our documentation and Arduino website for code retention.

II.   Reflection: Design Thinking Discussion
    a. Please read the paper before meeting

III.   Schedule Sub Group Meeting Times
    Power Circuit - Meets Fridays 2:00-2:30 p.m. TLA
    Chassis   - Meets Thursdays 2:00-2:30 p.m. Howe
    Rectification - Meets Fridays 11:30 a.m.-12:00 p.m. Marston 2200
    M.C.   - Meets Wednesdays 1:15 - 1:45 in TLA

IV.   Project Plan
    a. Present Individual Sections
        i.   Jon - Section 1
        ii.   Chuck - Section 2.1-2.5
        iii. Tania - Section 2.6-2.9
        iv.   Abdul - Section 2.10-2.13
        v.   Brian - Section 3-3.2
        vi.   Yan - Section 3.3-3.5
        vii. Section 4 - Everyone as necessary
    b. Combine Sections
        The document is under reports folder in the Senior Design Google Drive.

Individual Contributions:

Group Member	Accomplishments	Time Worked Last Week	Total Time Worked

Abdul	Met with Power Circuit and Rectification Circuit teams. Researched possible switching options, such as IGBT and thyristors and rectification options. Finally, met with ETG to know where they get the parts from, so I know where to search for components.	2	4
Yan	Obtained clearer understanding of budget, obtained eta from ETG on parts, worked on research for rectification and chassis. Had first sub-group meeting for chassis and rectification.	3.5	4.5
Jon	Installed Matlab and Matlab Arduino support packages. Created Arduino web IDE account and tested simple "Hello world!" program. Found bootloader on Arduino from ETG was faulty. Obtained second Arduino and tested communication with web IDE and Matlab. Both now connecting to Arduino OK. Updated team website with project documentation and team member info. Completed my section of Project Plan document. Created team process flowchart.	3	3
Brian	Met with Circuit and Rectification team, working block diagram for control circuit	2.5	3.5
Tania	Met with Power Circuit and Chassis Design Teams. Researched and evaluated an assigned switching device and made some more research on biphasic pulse.	1.5	5
Chuck	Met with Power Circuit and Chassis Design teams. For the power circuit team, we researched switching components. The chassis team researched materials to use for the chassis. Researched past patents and projects, as well as possible components. I wrote my project sections and edited the project plan sections together.	6	9

Deliverables:

- Semester 1:
  1. Early Concept Implementation and Simulation
  2. Design Circuit with High Current Carrying Components
  3. Programming of Micro-Controller to Control Pulses
  4. Select and Order Components

5. Assembly of Components

- Semester 2:
  1. Testing of the Pulsar

Individual tasks to be completed before next meeting:

Everyone:

- Project Plan
  o Complete individual subsections
  o Develop a Gantt Chart
- Weekly reflection
- Rectification Team
  o XFMR or Diodes?
  o Buck converter, switch-mode power supply, or SEPIC?
- Power Team
  o Which Switching Component to Use?

Summary of Weekly Advisor Meeting:

We as a team met with our clients to better define the objectives of our project. An understanding was reached in regards to waveform needs, range of loads, and machine usage.

Questions for Next Client Meeting: