EE/CPRE/SE 491 Weekly Report 4 Meeting Times 2:00 – 3:00 P.M. Mondays in TLA
Date: Week of February 19, 2018
Group Number 4

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.

- 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 is 120 V wall outlet.
  - Range of Load - 5 micro-Henry (min) to Max(Undefined)
  - 10 pulses a minute max
  - Circuit shall be biphasic
  - The device shall output multiple waveforms (Square, Sawtooth, etc.)

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:

  Presented and discussed findings on the emergency discharge circuit and capacitor storage circuit. Have a list of possible components for capacitors and resistors to present on Monday. Our quotes for the IRK thyristor is not coming back as fast as expected. Solutions to this problem are being explored if we are unable to get this part.

- Chassis Design:

  Made a rough scale of the chassis "box" using the dimensions of our components with spacing in between them. Discussed idea of implementing a design for easy transportation as well as discussing a way to implement a form of cooling in our design.

- Micro-Controller (M.C.):
  - Concluded that Matlab Arduino libraries are too limited and that running the Matlab server code on the Arduino to allow communication is restrictive.
  - Investigated serial communication and concluded that a serial connection between Matlab and Arduino would be a much more flexible method of control and data transmission.
  - Prototyped simple GUI to create serial connection and send a command to Arduino. Connection tested OK. Will be going forward with serial.

- Rectification Circuit:

  Made the rectification part of the circuit and picked out the wall transformer our group will use to deliver the 240+- that our power circuit is going to use. We ran component testing through Eagle and had to work through some software issues within Eagle to get the testing work.

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

Pending Issues:

I. Schedule Sub Group Meeting Times
   Power Circuit - Meets Fridays 11:15-12:00 p.m. TLA
   Chassis - Meets Thursdays 2:00-2:30 p.m. Howe
   Rectification - Meets Fridays 2 p.m.-3:00 p.m. TLA
   M.C. - Meets Wednesdays 1:15 - 2:00 in TLA

II. Due Dates

a. Weekly Report to be filled out by Saturday at midnight

III. Team Reports
   a. Update your sub team sections accordingly

New Business:

I. Have rough designs of your sub team circuits for next meeting.
   A. In conjunction with circuit designs, pick our parts needed for your sub team and up date Yan's spreadsheet as it comes along. Please earmark which sub team each part is for.

Individual Contributions:

Group Member	Accomplishments	Time Worked This Week	Total Time Worked
Abdul	In depth research for the capacitors will be used (i.e. brand, number, individual capacitance, time duration until we receive them ...etc.). Read more about rectification parts to gain more overall knowledge and understanding. Watched tutorials on simulation software and ran simulations on the rectification parst.	6	14
Yan	Created rough design for rectification to microcontroller, help figure out a early design for chassis box. made budget spreadsheet more user friendly, research pros and cons of the transformer we will be using, assisted in the final design of the rectification circuit, and messed around with the Eagle software.	5.5	14
Jon	Further explored Matlab support for Arduino and concluded that it is limited and restrictive since the Matlab server monopolizes the Arduino and provides limited functions. Learned about Matlab and Arduino serial connection and decided that a serial connection	4	14

	would allow programming the Arduino using native commands for much more flexibility while still allowing a control connection with the Matlab GUI. Prototyped simple GUI in Matlab with buttons to create/terminate a serial connection with Arduino and send a command to the Arduino. Prototype tested OK and I will be further developing the serial connection GUI.		
Brian	Read up on voltage multipliers, doublers and quadruplers. Had to troubleshoot eagle simulation software in order to run simulations with our desired software. Met with the microcontroller team and brought in an arduino kit so we could expand our options with the microcontroller. Had a meeting with Professor Tuttle to discuss our circuitry designs and questions we had over some current limiting designs. Learned about a circuit design called a " snubbing circuit".	8	15
Tania	Determined the chassis box dimensions with the Chassis team. Calculated different resistor values and quantities for the safety discharge circuit. Evaluated different resistors from digikey and made a comparison sheet with each of them	3	11
Chuck	Calculated wire ampacity and design specifications for the circuit. Calculated a current limiting resistor to be used in the capacitive storage circuit. Assisted in analyzing transient responses in the charging of the capacitor bank and possible capacitor components. Worked on possible solutions if we are not to get an equal thyristor the circuit is designed for.	9	27

Deliverables:

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

- Semester 2:

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1. Testing of the Pulsar

Individual tasks to be completed before next meeting:

Everyone:

Work on subteam circuit designs.

- Weekly reflection
- Rectification Team
  - XFMR
  - Buck converter, switch-mode power supply, or SEPIC?
  - Start initial circuit design
  - Start parts list
- Power Team
  - Which Switching Component to Use?
    - Price
  - Find parts for capacitors, resistors, diodes, and relays.
- Chassis Team
  - Have initial design done for monday
  - IR Camera
- M.C.
  - temp sensor
  - Current Sensing Resistor
  - Get first Matlab GUI window up

Chuck- Wire Diameter Calc

Summary of Weekly Advisor Meeting:

A power circuit design was proposed. It was accepted, and the power team is to continue designing and specing parts for the individual circuit components, caps., resistors, diodes, etc.

Rectification team suggested designing and building their own transformer and bridge rectifying circuit. This idea wasn't met with warm reception, but we sincerely encourage them to try and come up with a design. We will then compare their design to possible manufactured circuits. They will have a complete design and component options for the next advisor meeting.

Micro-Controller team decided against using a current sensing resistor because of cost, and is looking for other solutions to measure the current waveform through the circuit.

Questions for Next Client Meeting: