

# 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  $\mu$ s

- Rise/fall time of 100  $\mu$ s

- 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 monophasic;

- If successfully completed then a biphasic version shall be built.

- The device shall output multiple waveforms (Square, Sawtooth, Triangle, Sine)

## **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 3:00-5:00 p.m. Durham

Rectification Circuit: Abdul, Yan, Brian

-Meets Thursdays 3:00-5:00 p.m. Durham

Power Circuit: Tania, Curtis, Abdul

-Meets Thursdays 3:00-5:00 p.m. Durham

Micro Controller: Jon, Brian

-Meets Thursdays 3:00-5:00 p.m. Durham

\*NOTE: Teams with Brian need to reschedule their times after his schedule is finalized.

## **Weekly Summary:**

- Power Circuit: We confirmed circuit was in the correct configuration after unboxing. Designs were made to power several other microchips needed for microcontroller implementation
- Chassis Design: n/a
- Micro-Controller (M.C.): Created Triangle, Sine and Sawtooth output waveforms of desired frequency (36Hz) and 4.5V amplitude. Created function to manage charging/status of capacitors.
- Precision Electronics: PCB gerber files were verified and sent out to be ordered. Designed initial capacitor charge status circuit.

### **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. Due Dates
  - a. Weekly Report to be filled out by Wednesday at midnight
- II. Team Reports
  - a. Update your sub team sections accordingly

### **New Business:**

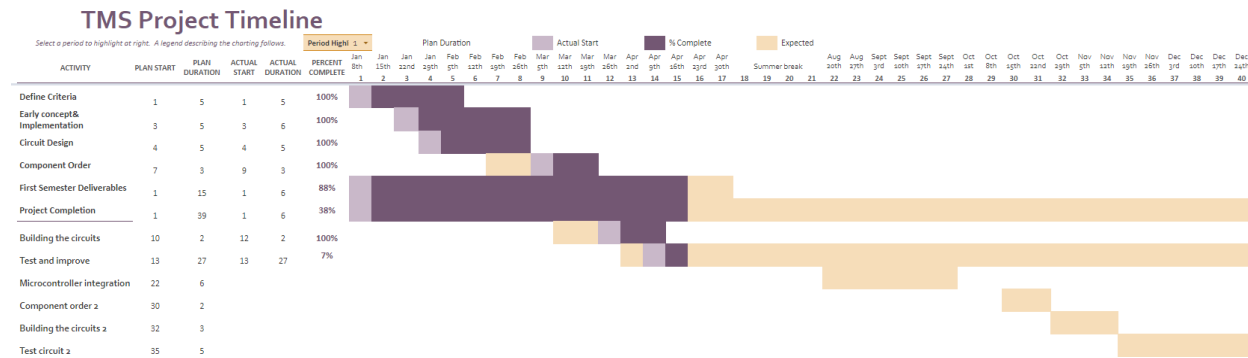
1. Meeting with Neelam and new Grad Students at 4:30 p.m.

### **Individual Contributions:**

Group Member	Accomplishments	Time Worked This Week	Total Time Worked
Abdul	Designed a circuit to output a variable voltage levels to power the IGBT.	4	8
Yan	Talked to Tuttle about the trace width issue with the PCB and got that resolved. Reviewed the PCB version of the Rectification circuit and have the designed sent out. Assisting in the circuit design for the precision electronics team.	4.5	8.5
Jon	Corresponded with Allegro Microsystems regarding	8	12

	<p>high current sensing ICs.</p> <p>Created triangle, sawtooth, and sinusoidal waveform outputs using microcontroller PWM with RC smoothing.</p> <p>Waveform outputs lose 0.5V from 5V microcontroller supply, producing a final triangle/sine output amplitude of approximately 4.5V</p> <p>Created function to manage charging/status of capacitors.</p>		
Brian	<p>Extracted the gerber files from the rectifier circuit.</p> <p>Explored several possible circuit designs for a capacitor charge status: Comparator, Voltage divider, Zener. Researched the voltage and current restrictions of the microcontroller and components within the design.</p>	7	11
Tania	<p>Reviewed design of alternate power for microchips.</p> <p>Searched for resistor for measuring the current through the coil.</p>	5	9
Chuck	<p>Supported designs of alternate power for microchips. Confirmed circuit configuration.</p>	5	9

**Current Progress:**



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**Individual tasks to be completed before next meeting:**

Everyone:

- Weekly reflection
- Chuck find SPICE file for transistor.

- Electronic Measurements Team
  - Measure inductance of test coil.
  - Begin design for measurement circuit
  - Additional Voltage measurement for Capacitors
- Power Team
  - Begin testing
  - Develop Additional power for Relay
- Chassis Team
  - IR Camera
- M.C.
  - Test integration of microcontroller with amplifier card. In particular, investigate amplification and preservation of input waveforms.
  - Add relay into circuit.
  - Investigate built-in IGBT temp sensor and evaluate potential to sense temp with MC

**Summary of Weekly Advisor Meeting:**

Priam says to track linearly using steps of like 15V 30V, or an improvised hall sensor. Continue using a resistor to measure current right now. Modeling the circuit to find max and min values for inductance the circuit can handle. Use a current source with the IGBT we are using and then sweep inductances to see how it handles the current.