

# 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, 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 2:00-3:00 p.m. Marston

Power Circuit: Tania, Curtis, Abdul

-Meets Fridays 11:15-12:00 p.m. TLA

Micro Controller: Jon, Brian

-Meets Wednesdays 1:15-1:45 in TLA

## **Weekly Summary:**

- Power Circuit:

We discussed the LED secondary circuit.

- Chassis Design:

Time over break was spent starting chassis construction. I have a  $\frac{3}{4}$  plywood base 1.5X1.5 ft., as specified in past calculations. This is where we will mount each of the pieces. The walls are constructed from a 1 -inch thick pine boards. I have a second plywood board that matches the base for the top of our box, but I would like to consult the rest of the chassis team, because I would like to propose we use a plexiglass top. This could really bring our project up a notch if our circuit looks “attractive”. If our circuit is ugly I suggest we stick to plywood. Another feature of the chassis will be a lock out-tag out lock. For those unfamiliar there is one key to every lock, and the lock will stop anyone without the key opening the box up and potentially damaging the circuit or themselves. When opened the lock will lock our plug preventing the circuit from becoming energized. The lock isn't practical during construction, but it will help users with safe practice when our project is finished

- Micro-Controller (M.C.):

Wrote a simple test method to pulse an LED via a command sent from Matlab using PWM pins on Arduino as opposed to digital output pins, which output 0 OR 5 volts only. A variable voltage is needed at the IGBT gate in order to vary current. Was able to vary voltages between 0 - 5 V while apparently maintaining signal requirements (frequency, duty cycle). Testing with a scope is needed to verify shape of actual signal generated. Additionally, testing with the IGBT connected to the MC is needed to verify final output shape from IGBT is correct.

- Rectification Circuit:

Our rectification team made advancements in our design. Our team ran a simulation of our rectification circuit in a circuit simulation software to ensure that there would be no irregularities.

### **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 Saturday at midnight

- II. Team Reports
  - a. Update your sub team sections accordingly

**New Business:**

- I. Design Document Have your Sections Done by Saturday at Midnight
  - Section 1: Jon
  - Section 2: Chuck & Brian
  - Section 3: Abdul & Tania
  - Section 4: Everyone as needed

II. Components

Ordered before spring break.

They have come in.

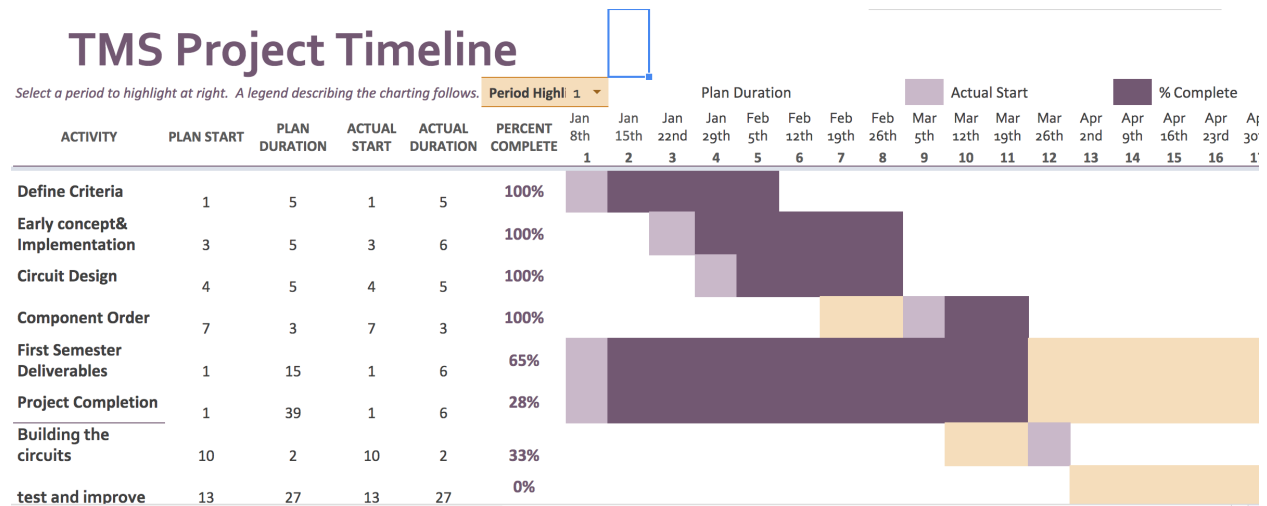
The resistors are huge!

**Individual Contributions:**

Group Member	Accomplishments	Time Worked This Week	Total Time Worked
Abdul	Worked on tracking changes affected by changing the design from biphasic to monophasic. Also, I did calculations for including multiple LEDs as indications that the capacitors are quarterly, half, and fully charged.	2	19
Yan	Uploaded the datasheet for our components and organized the datasheet in one folder, as well as updated our gantt chart for future usage.	3.5	20
Jon	Experimented with PWM output pins on Arduino. PWM pins will be used to produce variable 0-5 V	3	22

	signals at the IGBT gate to control current. Investigated what type of signal must be applied to IGBT (DC/AC/square wave).		
Brian	Assisted Abdul with the indicator light circuit for the charge on the capacitors. Reviewed the component list that will be ordered over spring break. Learned how to work with Eagle to run simulations with components.	5	23
Tania	Finalized components list. Agreed to have Chuck build the chassis box. Discussed Abdul's circuit	3	19
Chuck	I began building the chassis over spring break. Such design measures were taken to highlight safety, like lock out-tag out. We will be using a 3/4 in. plywood board for the base. I also compiled and edited our design document.	11	51

**Current Progress:**



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

Everyone:

Yan upload all the data sheets from bill of materials to one folder

- Weekly reflection
- Rectification Team
- Power Team
  - IGBT Gate Voltage
  - Abdul

LED for when there is charge in the capacitors.

- Chassis Team

- IR Camera
- M.C.
  - temp sensor (potential for measuring temp with NCT pins on IGBT?)
  - Current Sensing Resistor
  - Get first Matlab GUI window up (done)

**Summary of Weekly Advisor Meeting:**

We discussed the finished bill of materials. After all approvals were met, we went ahead and ordered all the components through the ETG.