

# 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

## **Weekly Summary:**

- Power Circuit: The load was changed per the suggestions of Priyam and JP. They suggested that our resistors we were using to find the current was creating a voltage that would change the  $V_{ge}$  to the threshold voltage. After replacing our 2 ohm resistor with a wire that has a resistance of about .03 ohms. This increased our current through the load to 30 amps.
- Chassis Design: n/a (Will finish chassis after circuit is tested and complete.)
- Micro-Controller (M.C.): Additional code cleanup and testing. Continuing to prep for integration of MC with capacitor charge control and detection circuit, and with the main device.
- Precision Electronics:

### **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:**

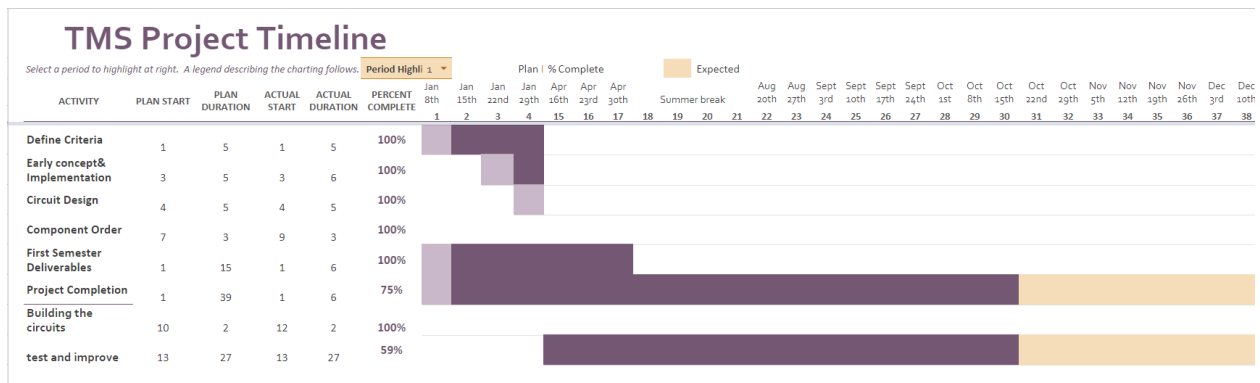
1. JP and Priyam suggest we remove the current sensing resistors on the load, and replace it with a wire of minimal resistance.

### **Individual Contributions:**

Group Member	Accomplishments	Time Worked This Week	Total Time Worked
Abdul	Did more simulations on IGBT circuits and read more on IGBT functionalities	4	31.5
Yan	Worked with Chuck to fix some testing issues and kept testing the circuit. Did some light soldering work.	4	36.5

Jon	<p>Worked in lab with Chuck and Tania testing IGBT.</p> <p>Discussed with Brian about progress of capacitor charge detection circuit.</p> <p>Tested MC pulse timing with oscilloscope.</p> <p>Started working on experimentally determined lookup table to set pulse frequency based on value set in GUI.</p> <p>Created additional utility/helper functions to support Bluetooth/Matlab communication.</p>	4	37
Brian	<p>Followed up with ETG on parts order, found out some error occurred and they needed to reorder.</p> <p>Assisted Jon with the parts integration with the microcontroller. Worked on Eagle design.</p>	6	37
Tania	<p>Worked with Chuck to fix some testing issues and kept testing the circuit</p>	4	36.5
Chuck	<p>We fixed the load based off of the suggestions of JP and Priyam. I continued testing on the circuit</p>	4	39

**Current Progress:**



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

Everyone:

- Weekly reflection
- Senior Design Report
- Chuck find SPICE file for transistor.
- Abdul simulate circuit sweep for the inductor coil
- Test IGBT

- Electronic Measurements Team
  - Measure inductance of test coil
  - Additional Voltage measurement for Capacitors
  - Build Capacitor Charging Indicator Circuit
- Power Team
  - Begin testing using old pulsar
  - Wire in the Relay
- Chassis Team
  - IR Camera
- M.C.
  - Continue preparing and testing for integration of MC with charge detection and control circuit and with main device
  - Add relay into circuit (waiting on components and Precision Electronics team)
  - Investigate built-in IGBT temp sensor and evaluate potential to sense temp with MC (low priority, heat not a concern)
  - Continue testing IGBT signal output system (MC --> op-amp --> IGBT)
  - Work with Brian on capacitor charge level detection circuit integration with MC (waiting on components)

**Summary of Weekly Advisor Meeting:**

The advisor meeting was rather short. We explained our finding from switching the load, and our new found maximum current. The heading will be kept to increase our current to maximum limits!