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ECE 445

Tesla Coil Links

Prev Projected that built one to play NES music: [getfile.asp (illinois.edu)](https://courses.engr.illinois.edu/ece445/getfile.asp?id=12773)

ECE 445 Safety Rules: [safety.pptx (live.com)](https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fcourses.grainger.illinois.edu%2Fece445%2Flectures%2FFA_2023_Lectures%2Fsafety.pptx&wdOrigin=BROWSELINK)

Tesla Coil Safety: [Tesla Coil Safety (ucsc.edu)](http://scipp.ucsc.edu/outreach/tesla/teslacoil/safety.html#:~:text=Safety%201%201.%20Make%20sure%20that%20the%20power,is%20present%20on%20any%20part.%20...%20More%20items)

Project Build on Musical Tesla Coil: [How to Make a Musical Solid State Tesla Coil (SSTC) That Plays Guitar! : 14 Steps - Instructables](https://www.instructables.com/How-To-Make-A-Musical-Solid-State-Tesla-Coil-SSTC/)

Guy who built it (Can ask safety questions maybe): [(11) Max Simmonds | LinkedIn](https://www.linkedin.com/in/max-simmonds/)

Project Build on super strong Tesla Coil (we would use this for ideas but DEFINITELY downsize): [How to Build a 1.1 Million Volt Tesla Coil! : 19 Steps (with Many Pictures) : 22 Steps - Instructables](https://www.instructables.com/How-to-Build-a-11-Million-Volt-Tesla-Coil/)

Project Build on homemade Tesla Coil (GreatScott - trustworthy channel): [Make your own Tesla Coil (Part 1) || Slayer Exciter Circuit - YouTube](https://www.youtube.com/watch?v=LbTyEratSTI&ab_channel=GreatScott%21)

Another project Build on homemade Tesla Coil: [The Ultimate Tesla Coil Build Guide (HD): EVERYTHING you need to know! - YouTube](https://www.youtube.com/watch?v=wiaehhgtasM&ab_channel=LabCoatz)

Notes for RFA Safety

* Test outside, set up cones and make everyone keeps 10ft away
* All comps other than coil can be built and tested indoors
* Power lab has said I may be able to build my components in there
* Coil sparks are 50kV, but very low current -
* Roughly 240V going into coil transformer, which the power lab can supply easily
* Since a person will hold a guitar, use a phototransistor so that the user is not electrically connected to any part of the circuit at all
  + IGBTs also have isolation in them

Signal can use IGBT’s

**RFA:**

# Tesla Coil Guitar Amp

Team Members:

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# Problem:

Musicians are known for their affinity for flashy and creative displays and playing styles, especially during their live performances. One of the best ways to foster this creativity and allow artists to express themselves is a new type of amp that is both visually stunning and sonically interesting.

# Solution:

We propose a guitar amp that uses a Tesla coil to create a unique tone and dazzling visuals to go along with it. The amp will take the input from an electric guitar and use this to change the frequency of a tesla coil's sparks onto a grounding rod, creating a tone that matches that of the guitar.

# Solution Components:

## Audio Input and Frequency Processing -

This will convert the output of the guitar into a square wave to be fed as a driver for the tesla coil. This can be done using a network of op-amps. We will also use an LED and phototransistor to separate the user from the rest of the circuit, so that they have no direct connection to any high voltage circuitry. In order to operate our tesla coil, we need to drive it at its resonant frequency. Initial calculations and research have this value somewhere around 100kHz. The ESP32 microcontroller can create up to 40MHz, so we will use this to drive our circuit. In order to output different notes, we will use pulses of the resonant frequency, with the pulses at the frequency of the desired note.

## Solid-state switching -

We will use semiconductor switching rather than the comparably popular air-gap switching, as this poses less of a safety issue and is more reliable and modifiable. We will use a microcontroller, an ESP 32, to control an IR2110 gate driver IC and two to four IGBTs held high or low in order to complete the circuit as the coil triggers, acting in place of the air gap switch. These can all be included on our PCB.

## Power Supply -

We will use a 120V AC input to power the tesla coil and most likely a neon sign transformer if needed to step up the voltage to power our coil.

## Tesla Coil -

Consists of a few wire loops on the primary side and a 100-turn coil of copper wire in order to step up voltage for spark generation. Will also require a toroidal loop of PVC wrapped in aluminum foil in order to properly shape the electric field for optimal arcing. These pieces can be modular for easy storage and transport.

## Grounding rod -

All sparks will be directed onto a grounded metal rod 3-5cm from the coil. The rest of the circuit will use a separate neutral to further protect against damage. If underground cable concerns exist, we can call an Ameren inspector when we test the coil to mark any buried cables to ensure our grounding rod is placed in a safe location.

## Safety -

Tesla coils have been built for senior design in the past, and as noted by TAs, there are several safety precautions needed for this project to work. We reviewed guidelines from dozens of recorded tesla coil builds and determined the following precautions:

\* The tesla coil will never be turned on indoors, it will be tested outside with multiple group members present using an outdoor wall outlet, with cones to create a circle of safety to keep bystanders away.

\* We will keep everyone at least 10ft away while the coil is active.

\* The voltage can reach up to 100kV (albeit low current) so all sparks will be directed onto a grounding rod 3-5cm away, as a general rule of thumb is each 30kV can bridge a 1cm gap.

\* The power supply (120-240V) components will be built and tested in the power electronics lab.

\* The coil will have an emergency stop button and a fuse at the power supply.

\* The cable from the guitar will use a phototransistor so that the user is not connected to a circuit with any power electronics.

# Criterion for Success:

To consider this project successful, we would like to see:

\* No safety violations or injuries.

\* A tesla coil that produces small visible and audible 3-5cm sparks to our ground rod.

\* The coil can play several different notes and tones.

\* The coil can take input from the guitar and will play the corresponding notes.

* Set up regular meeting time
* Draw very high abstraction design of what our system will look like - ensure we agree on the general look of the design
* Break up into clearly defined modules and prioritize (determine order of operations)
* Determine most important parts we will need particularly for power components,
  + Figure out which of these parts are candidates for the machine shop
  + Order: Microcontroller, Transistors, Gate Drivers, Rectifier
  + Determine parts we also need to order: Grounding rod, coil wire, protection
  + Look into HV Xfrmr/Variac
  + List everything we want, then separate into order vs find
* Set up meeting with machine shop - in particular, can they build the coil and/or transistor heat sinks