* 100–200-word elevator pitch

Our project was to design and fabricate a generator device known as an electrosurgical unit (ESU) used to supply an RF signal to another medical device known as the Ligasure used in vessel sealing and tissue cauterization applications. Technological advancements in electrosurgery such as the ESU and vessel sealing applications in the developed world have been shown to reduce operation times, post-surgery pain, and expedited recovery times. However, at the moment, many middle and lower-income countries do not have access to ESU generators due to their high cost and large size. Therefore, the goal of our project was to create a more accessible ESU that was both cost-effective and space-efficient while not compromising its vessel-sealing capabilities.

* 200–500-word description of your product

The signal that our ESU was required to provide was a 431 kHz bipolar RF signal with an open circuit voltage of 324 V (). This signal generated by the ESU is delivered to the electrodes of the two-pronged jaw of the Ligasure device in which the tissue site of interest (that is clamped down by the jaws) would then act as the effective load of our system.

Our system would be supplied with a 48 V DC signal which would either be provided by a Medtronic-manufactured wall-to-system AC-DC converter or a 48V battery system. This DC signal would be supplied to a phase-shifted full bridge (otherwise known as a full-bridge inverter) in which the gate signals of each MOSFET would be controlled by PWM signals from our TI Piccolo microcontroller. By taking the differential of each side of the bridge, the output signal of the phase-shifted full bridge is a bipolar square wave AC signal of 431 kHz (peak-to-peak 96 V). Depending on the PWM signal supplied to the gates of the MOSFETs, the user of our device (via GUI) can control the duty cycle of the square wave produced by the phase-shifted full bridge which will vary the power output of our system: the variable input is known as the Cphase (0-180 degrees)

This output square wave AC signal will then be supplied to the next circuit module of our system known as a resonant tank which consists of a low pass filter (LCC topology with a cutoff at approximately 860 kHz) and a step-up transformer (turns ratio of 2.5). After the resonant tank, all harmonics except the fundamental of the square wave signal supplied by the phase-shifted full bridge should be attenuated (bipolar sine wave AC signal 431 kHz). Furthermore, in the case that we have a perfect square wave (Cphase input of 180 degrees), the bipolar sine wave output of the resonant tank will have a peak-to-peak voltage of approximately 331V.

The last circuit module is an isolation transformer (unity turns ratio) which will provide a ground return path for the signal delivered to the tissue to ensure that no electrical current is dissipated through the patient. The voltage and current delivered to the load of our system (tissue) will be measured by a voltage and current sensor circuit topologies which will feed a scaled-down signal back to the ADCs of our microcontroller to be displayed on a serial port python GUI which will display real-time voltage and current graphs of the signal delivered at the load.