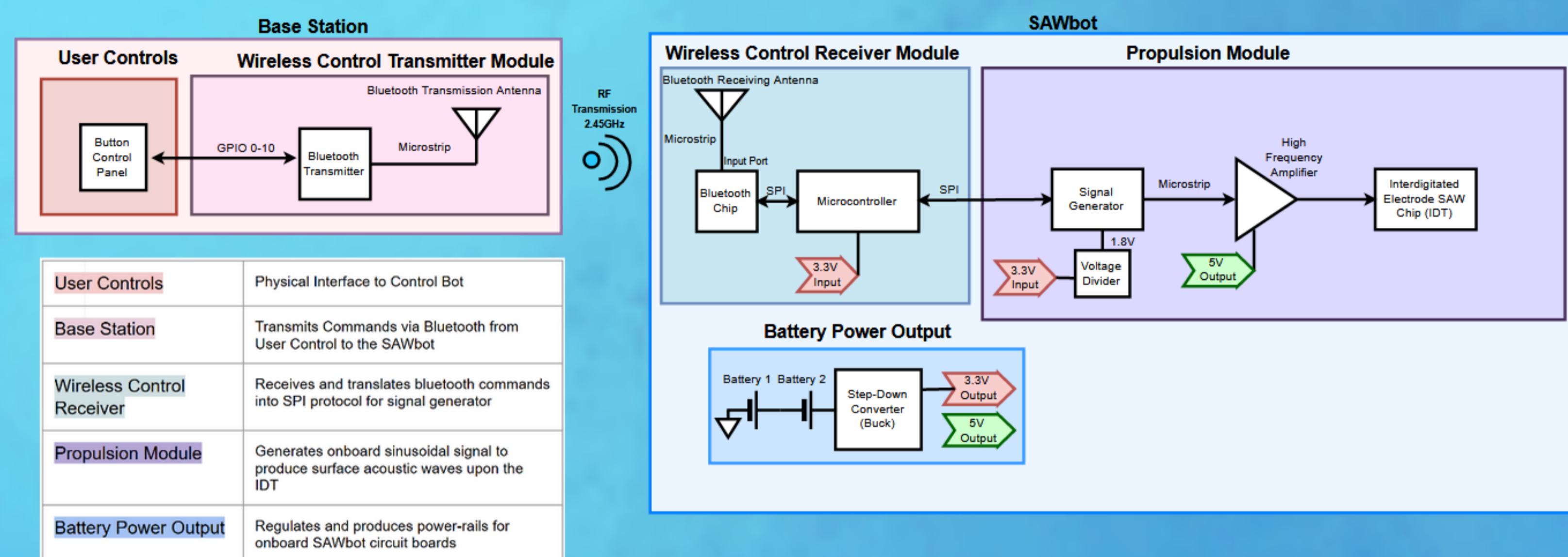


# SAWbots: A Platform for Affordable Minimally Invasive Surgeries

Remotely controlled miniature robot that traverses liquid surfaces with no motors or moving parts  
 Developed by Dr. Yanik's Research Lab in conjunction with Nic Van Oss, Allie Hunsinger, Phil Canete, Summer Alherz, and Alex Bakaleynik

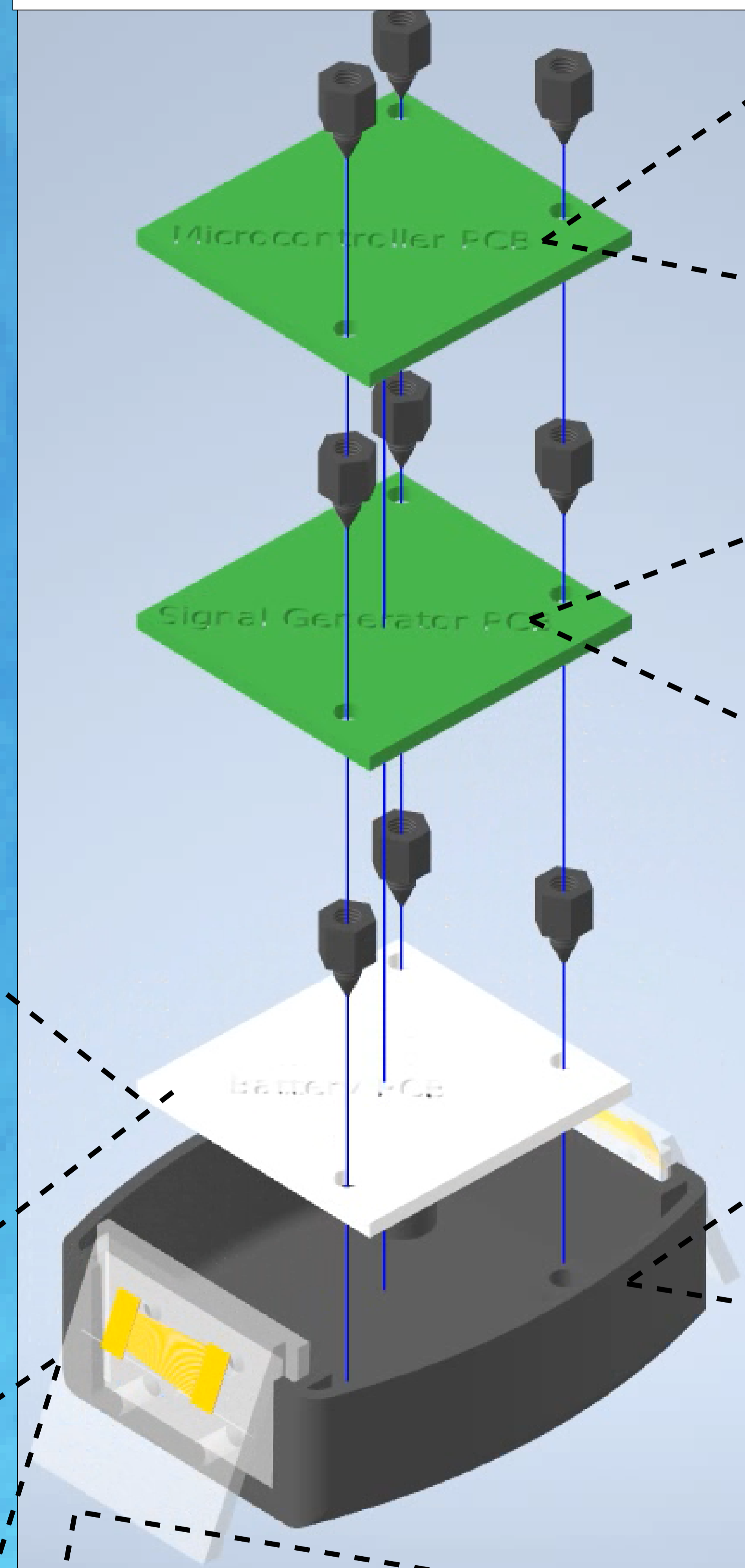
There is currently a lack of minimally invasive procedure (MIP) technology in the medical industry. This type of technology significantly decreases the size and number of incisions needed to operate, which has been shown to improve patient outcomes when compared to traditional surgery. SAWbots provide the optimal solution by providing MIP technology at a decreased cost, thereby making safer surgery more accessible to the medical field. This project improves upon a novel form of propulsion in fluid in compliance with our stakeholder's requirements. The team used Yannik Bourquin and Jonathan M. Cooper's *Swimming Using Surface Acoustic Waves* as a starting point for our research and benchmark for our results.

## System Overview Block Diagram

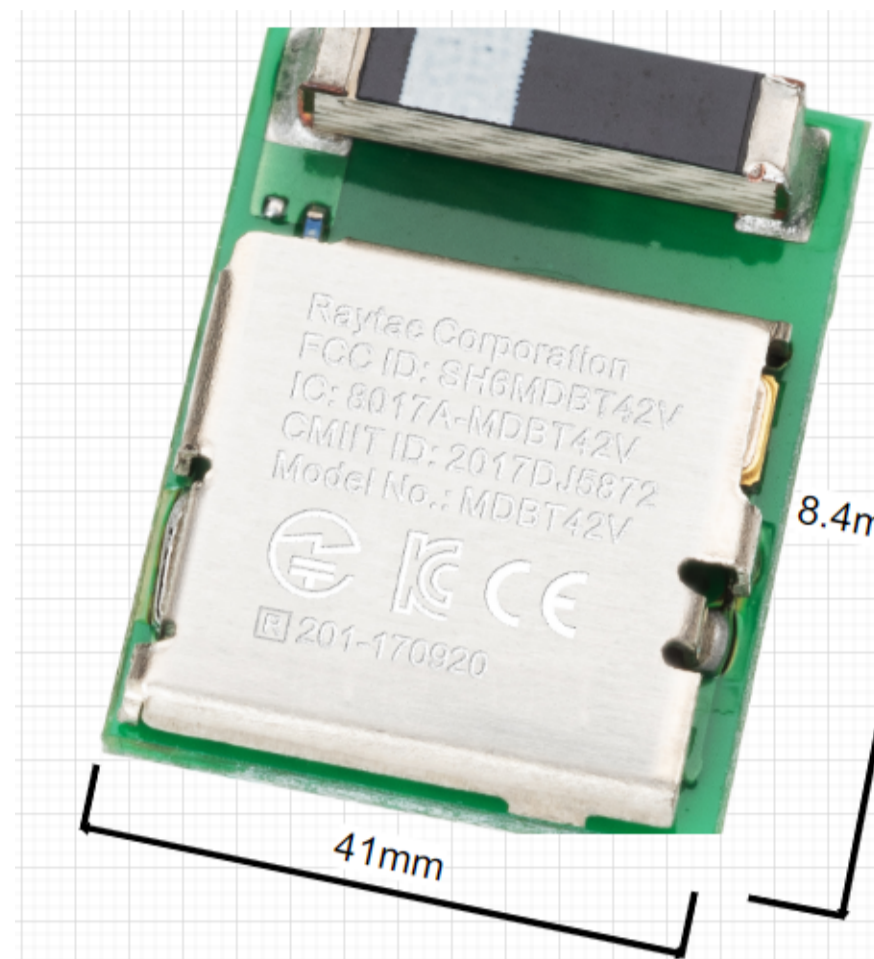


## Assembly

Expanded 3D model of surface acoustic wave SAWbot

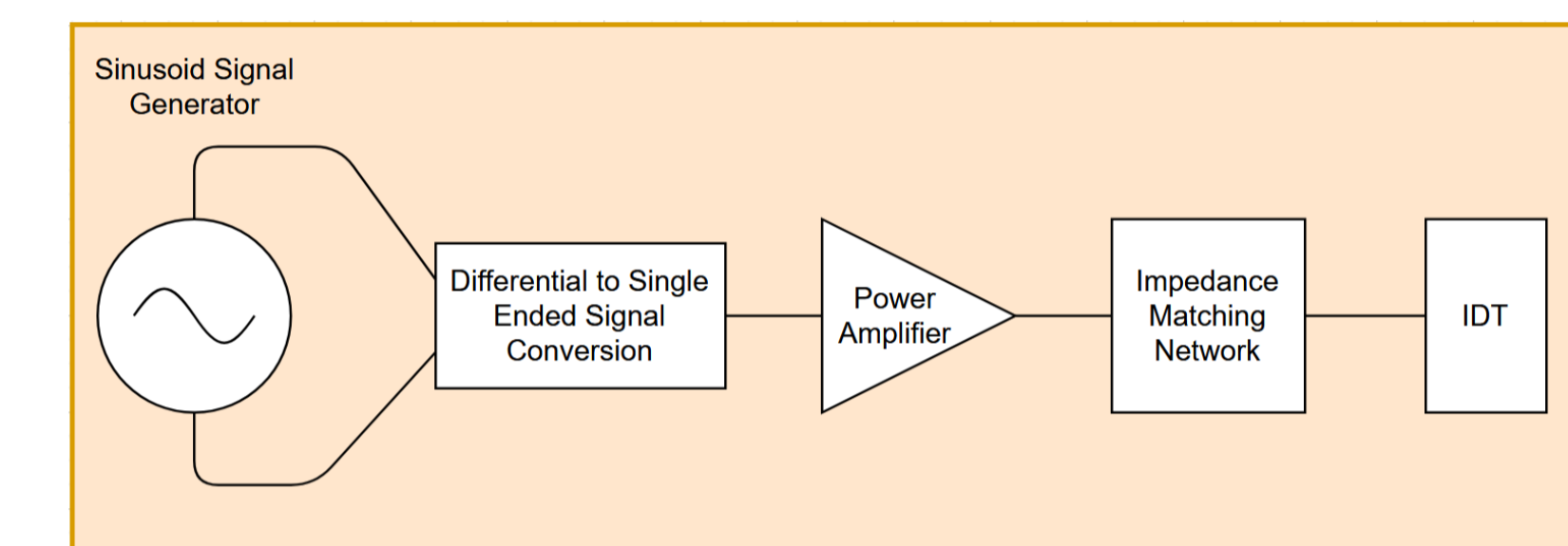


## Onboard Microcontroller



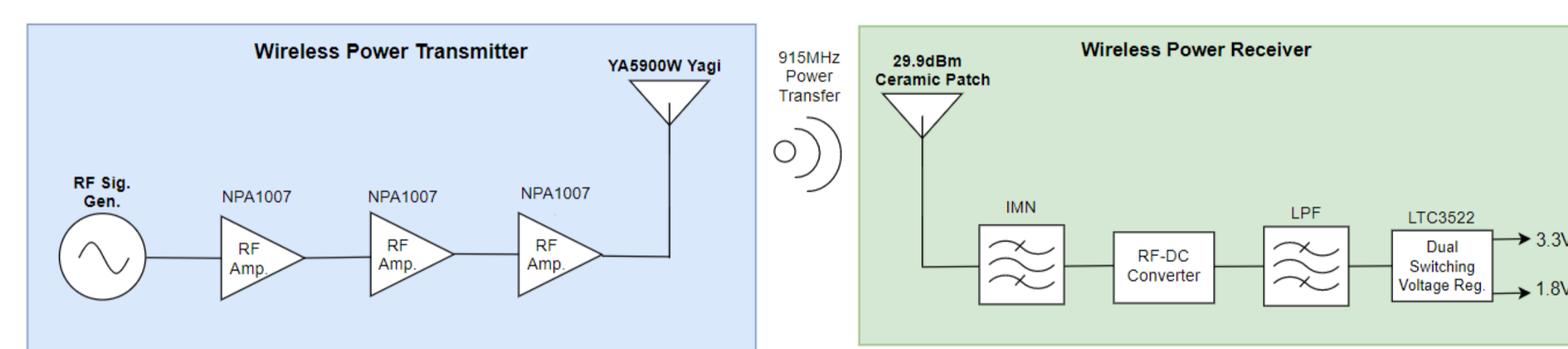
- Receives inputs from offboard control panel
- Controls signal generator via SPI to move bot
- Bluetooth 5.1 Low Energy based communication - 10x more power efficient than WiFi

## On Board Signal Generation



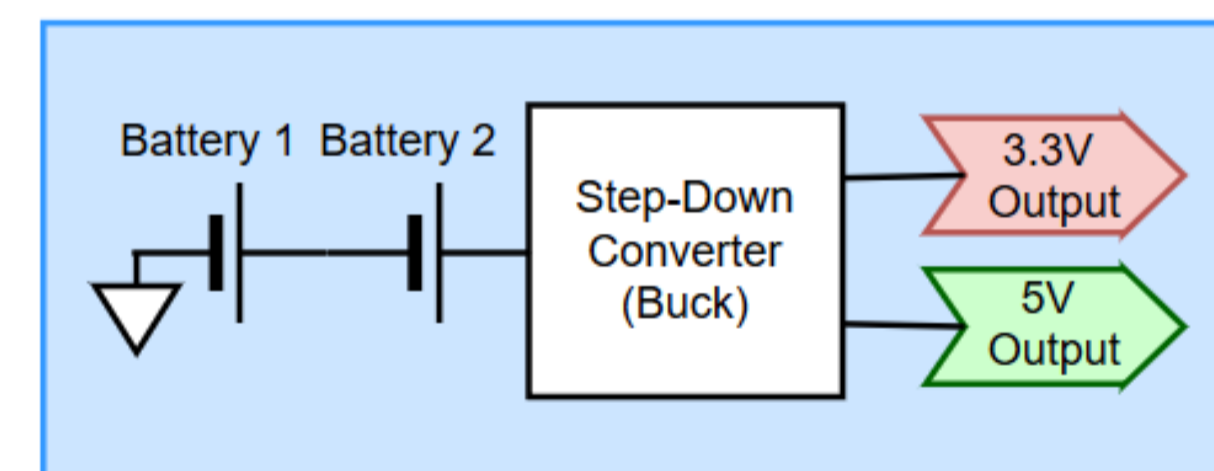
Propulsion Module Block Diagram  
 The AD9913 Digital Synthesizer generates a variable high-frequency sinusoid; this waveform is amplified to provide electrical power to excite the IDT

## RF Power



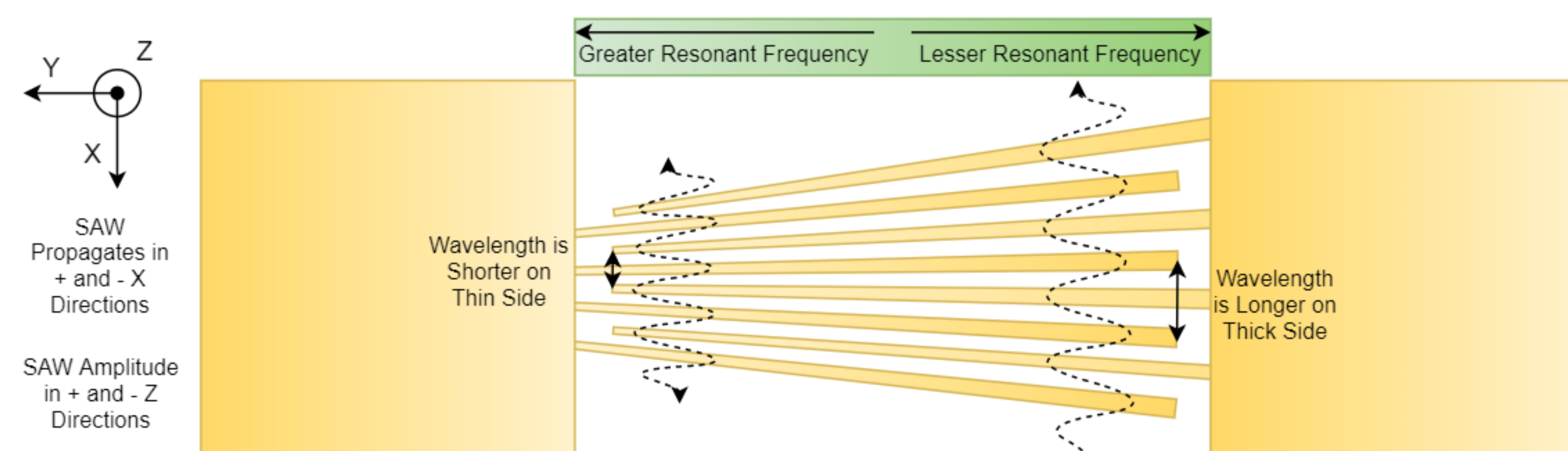
Block Diagram of Simulated Wireless RF Power System  
 RF Signal Amplified, Transferred to Receiver, and then Converted to DC Power

## Battery Power



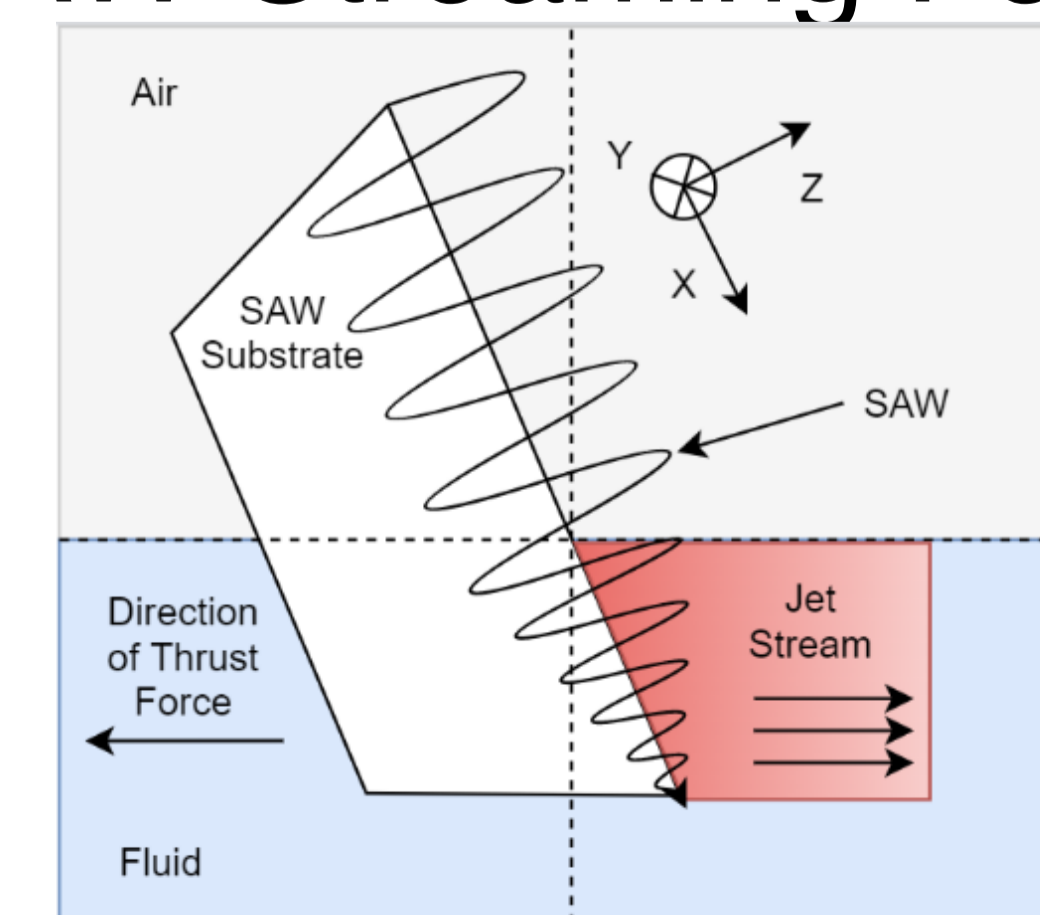
Block Diagram of Battery System  
 Battery Output Sent through Dual Converter to Provide DC Power Rails

## IDT SAW Generation



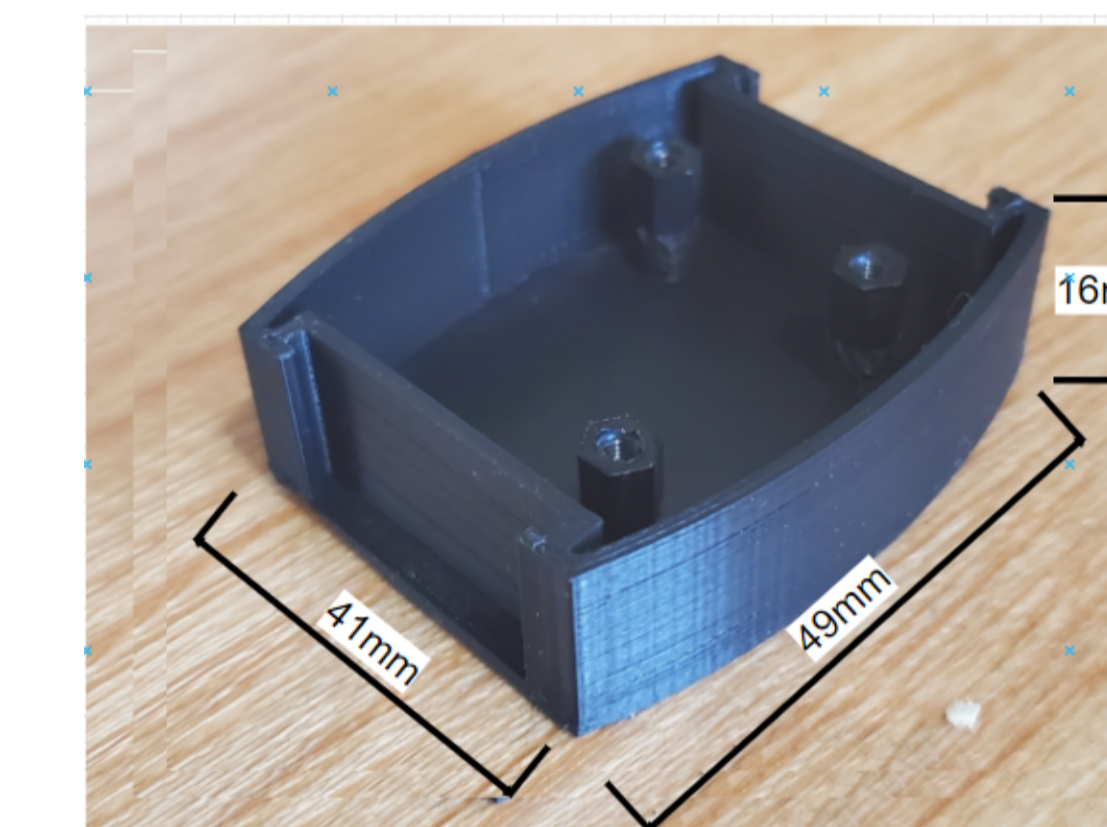
**Interdigital Transducer:** IDTs excite SAWs in piezoelectric substrate in response to AC voltage. IDTs with Slanted Fingers provide control of the y-axis location of the SAW beam through varying the frequency of the AC input. Thus, by varying our electrical input frequency, we can generate thrust at different locations and steer the robot

## SAW Streaming Force



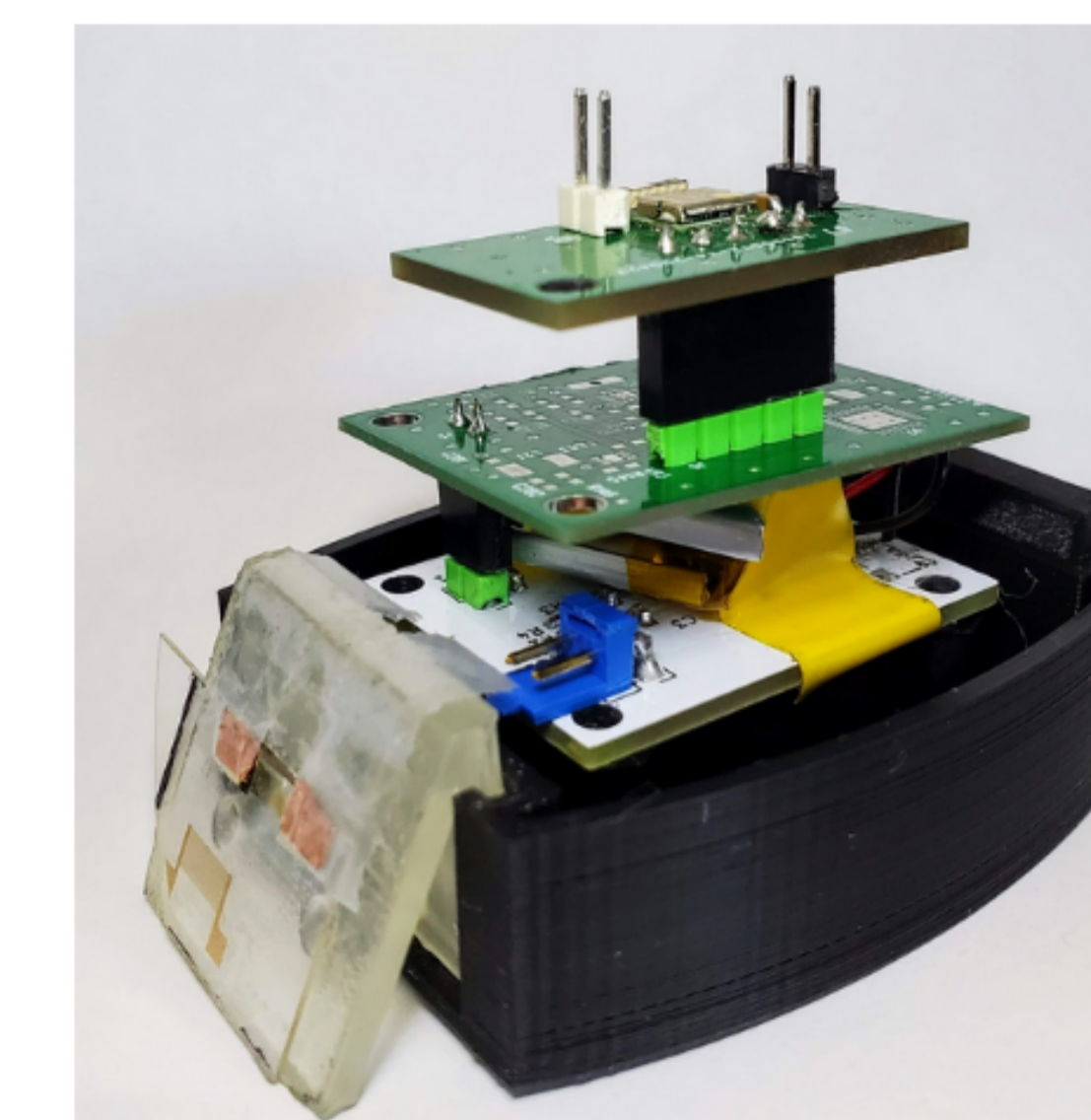
**SAW Streaming:** When a SAW enters a fluid interface, it attenuates and leaks energy into the fluid, generating a streaming force

## Chassis



- 3D printed in biodegradable PLA
- Waterproofed using spray-on coating
- Designed for rapid, modular prototyping

## Final Design Prototype:



The final prototype houses three circuit boards. These boards enable communication with the base station, provide on-board signal generation, and deliver battery power to the bot. The IDTs are mounted to provide maximum thrust. The bot is expected to generate 1mN of thrust which is 10x more efficient than ultrasonic thrusters.

### Physical Bot

Isometric view of the physical bot  
 Length: 48.5 mm Width: 40.6 mm  
 Height: 16.5 mm