RF-Power Amplifier

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BACKGROUND

DryMax is located in Cokato, Minnesota and is a cutting edge innovative company researching, testing and building methods of drying various grains and biomass. These new methods they are developing lower costs for drying, increase quality, and produce no pollution. Conventional methods of drying are by way of propane which is about three times as expensive, doesn't dry as consistently, and has a bi-product of producing pollution. Potential customers of DryMax include farmers and waste facilities.

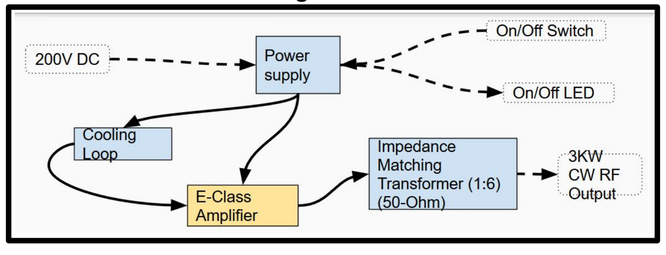
Problem Definition

To create an E-Class RF amplifier to efficiently achieve a 3KW output at 13.56 MHz The goal is for this amplifier to be used by itself or in tandem with more instances of it to supply radiate heat in order to dry biomass, such as grain, faster than current methods and at a less expensive cost.

PROPOSED SOLUTION

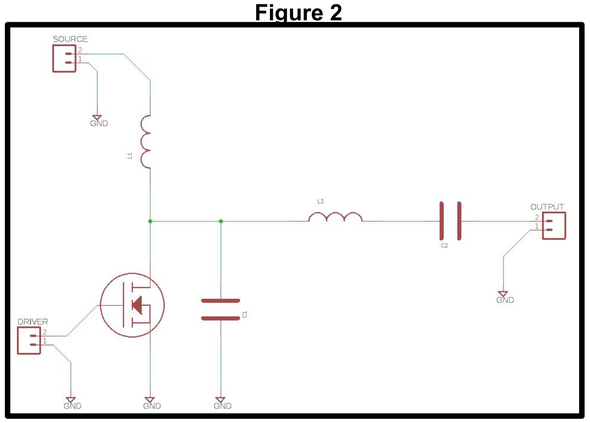
The RF power supply that we are building for DryMax is one that takes 200VDC as an input and outputs 48VDC to the E-class Amplifier and 5VDC to the Phase-shift oscillator. The Phase-shift Oscillator produces an RF output of 13.56 MHz and the E-class Amplifier boosts this output to a 3KW output to the impedance matcher which in turn creates a 50 ohm impedance of this 3KW output. The amplifier will be completely solid state achieving an efficiency minimum of 80% with an allowable max reflected CW power of 25%. This RF amplifier will exceed FCC requirements. It will have a Mean Time Between Failure of 100,000 hours and will include controls or displays for I/O RF on/off and a Unit "On" LED to indicate and control the status of the unit.

Figure 1



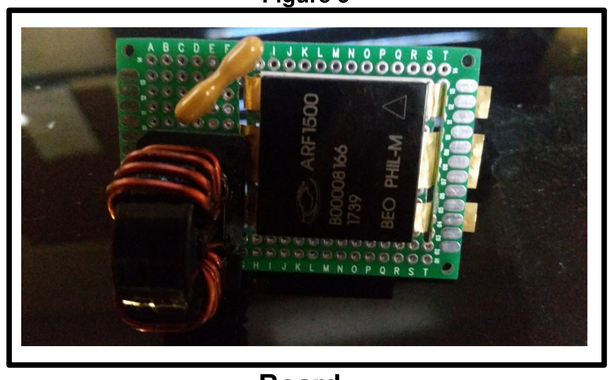
SYSTEM DESIGN

Figure 2



E-Class Amplifier

Figure 3



Board

FUTURE DIRECTION

- Circuit driver and power supply need to be included in future product
- Implementation of greater thermal concerns and solutions
- Custom PCB board design and housing

REFERENCE

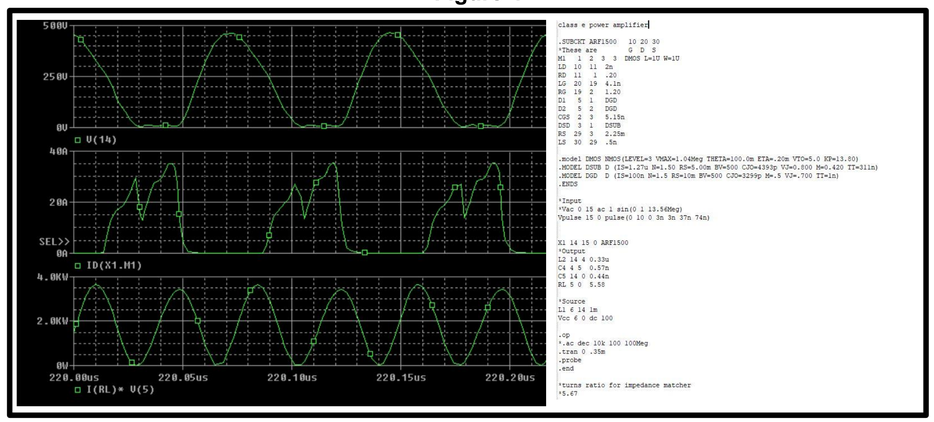
[1]Class-E Power Amplifier, Richard Kubowicz, 2000

[2]High Voltage, High Efficiency MOSFET RF Amplifiers, Richard Frey, P.E., APT0001

[3]Class-E Calculator, Dimitris, http://people.physics.anu.edu.au/~dxt103/calculators/class-e.php

RESULTS

Figure 4



P-SPICE Simulation

Figure 5

Input (red)/Ouput (Yellow)

- Pspice expected results gave 2-3kW output
- Best amplification was 2.86x (Figure 5) This was with a sine wave input instead of the desired squarewave. Also, the source was a 6V battery (4xAA's).

DESIGN CHALLENGES

- Encountered erroneous results initially in our Spice models which delayed progress
- Design used prebuild driver and source which underperformed. The driver was unable to supply the appropriate voltage or waveform and the source was unable to supply the required power
- Realized cost of designing a full on 12 KW amplifier would be very excessive >$5000
- The cooling system design cooled the amplifier in inadequate ways

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CONTACT INFORMATION

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