Passive RF Energy Harvester at 5.8 GHz

MITCHELL PERICAK ’17
BRADLEY UNIVERSITY
DEPT. OF ELECTRICAL ENGINEERING

ADVISORS: DR. BRIAN HUGGINS & DR. PRASAD SHASTRY

BRADLEY University
Department of Electrical
and Computer Engineering

What to Expect

- What is RF Energy Harvesting?
- History, Patents, Purpose
- Project Goals
- Diagram
- Matching Network
- Designs
- Conclusion

What is RF Energy Harvesting?

- RF signal is broadcasted from transmitter.
- RF signal is rectified by a series of diodes and capacitors to yield a DC output.

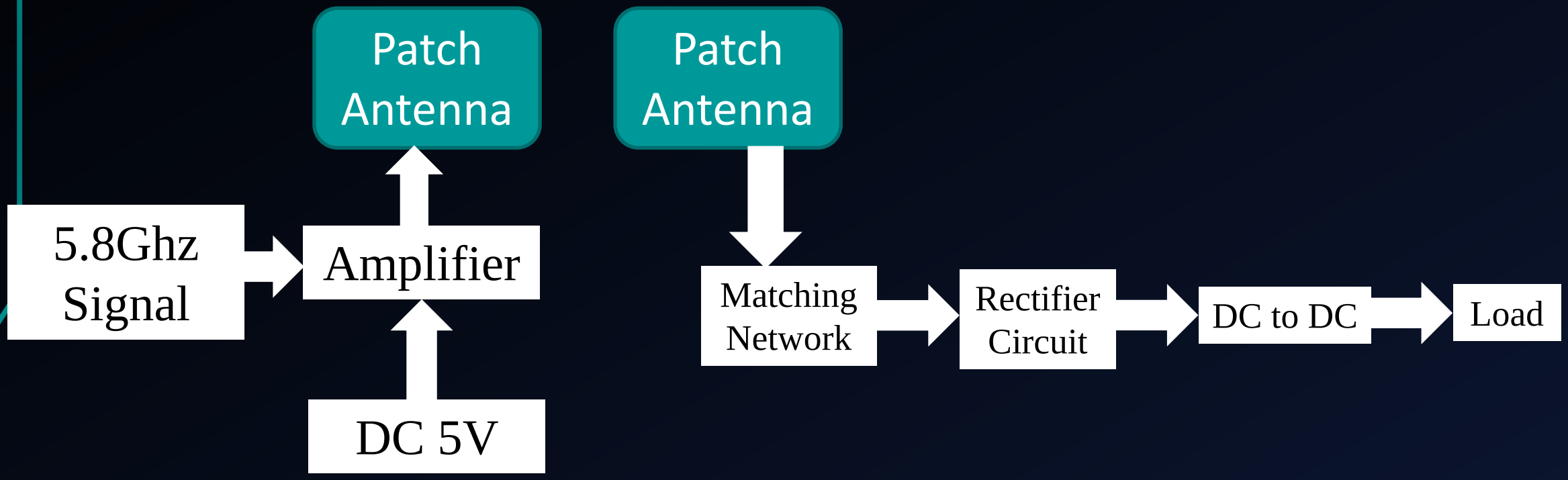
Patents

- Ford Global Technology
- MIT Research
- Apple 3’ Distance Charging

Scope of Project

- Design a rectifier that takes an input of 5.8GHz and produces an output voltage high enough to feed a DC to DC converter to charge a small battery or power a small sensor.

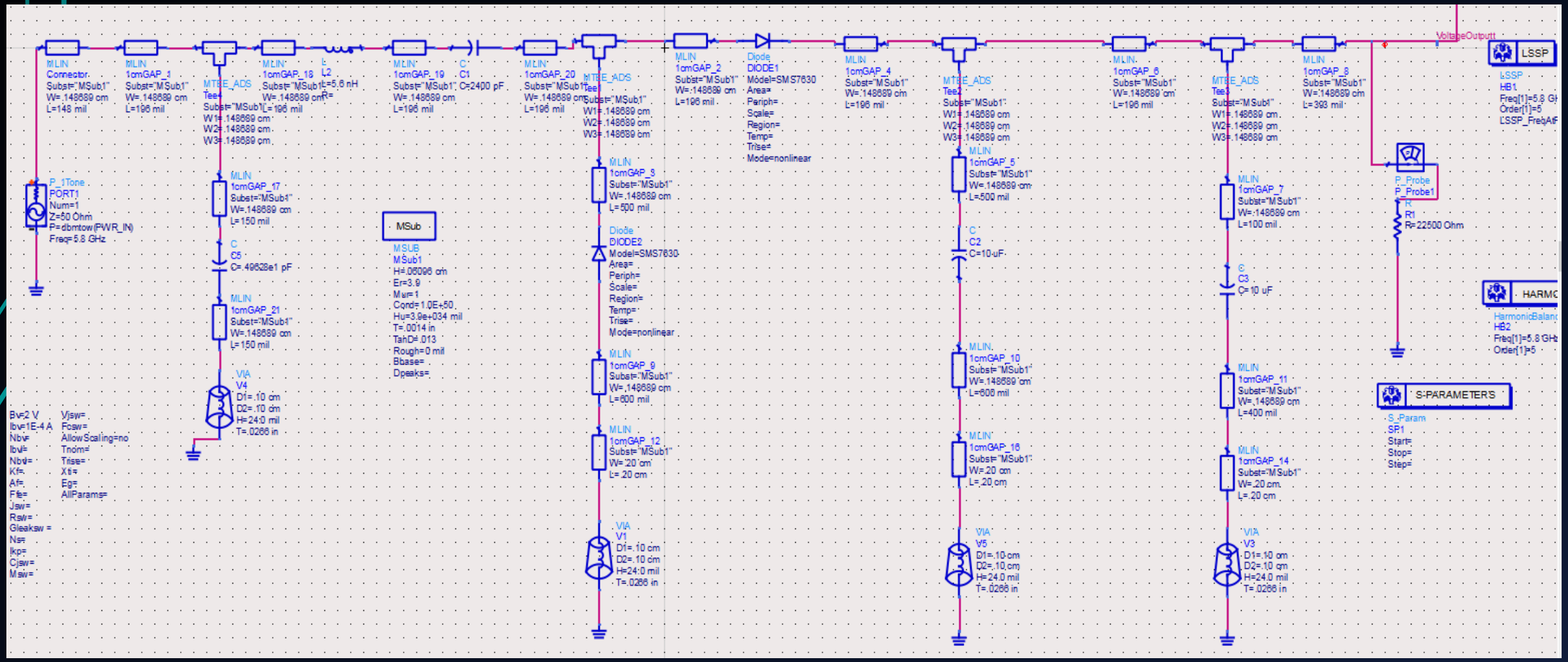
Subsystem Diagram



What is a matching network?

- Matching Network: Transfer maximum power from the antenna to the circuit.
- The rectifier is non linear so there is issues with the matching network completing its intended function. It is not clear if the matching network can truly optimize an RF harvester.

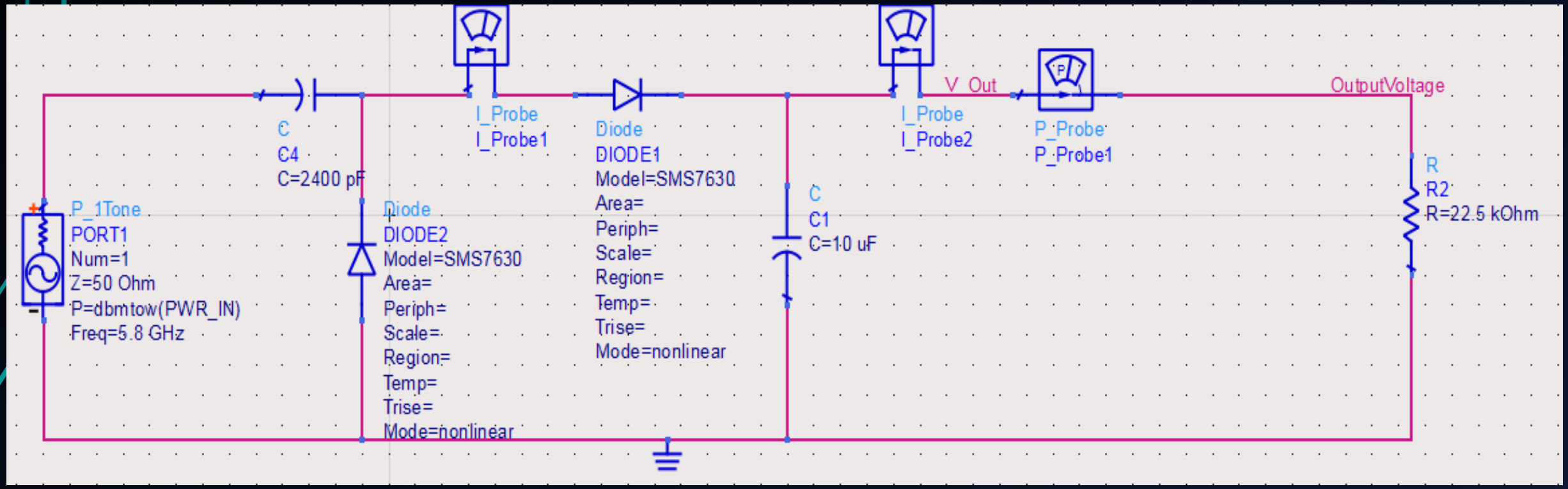
Design With Matching Network



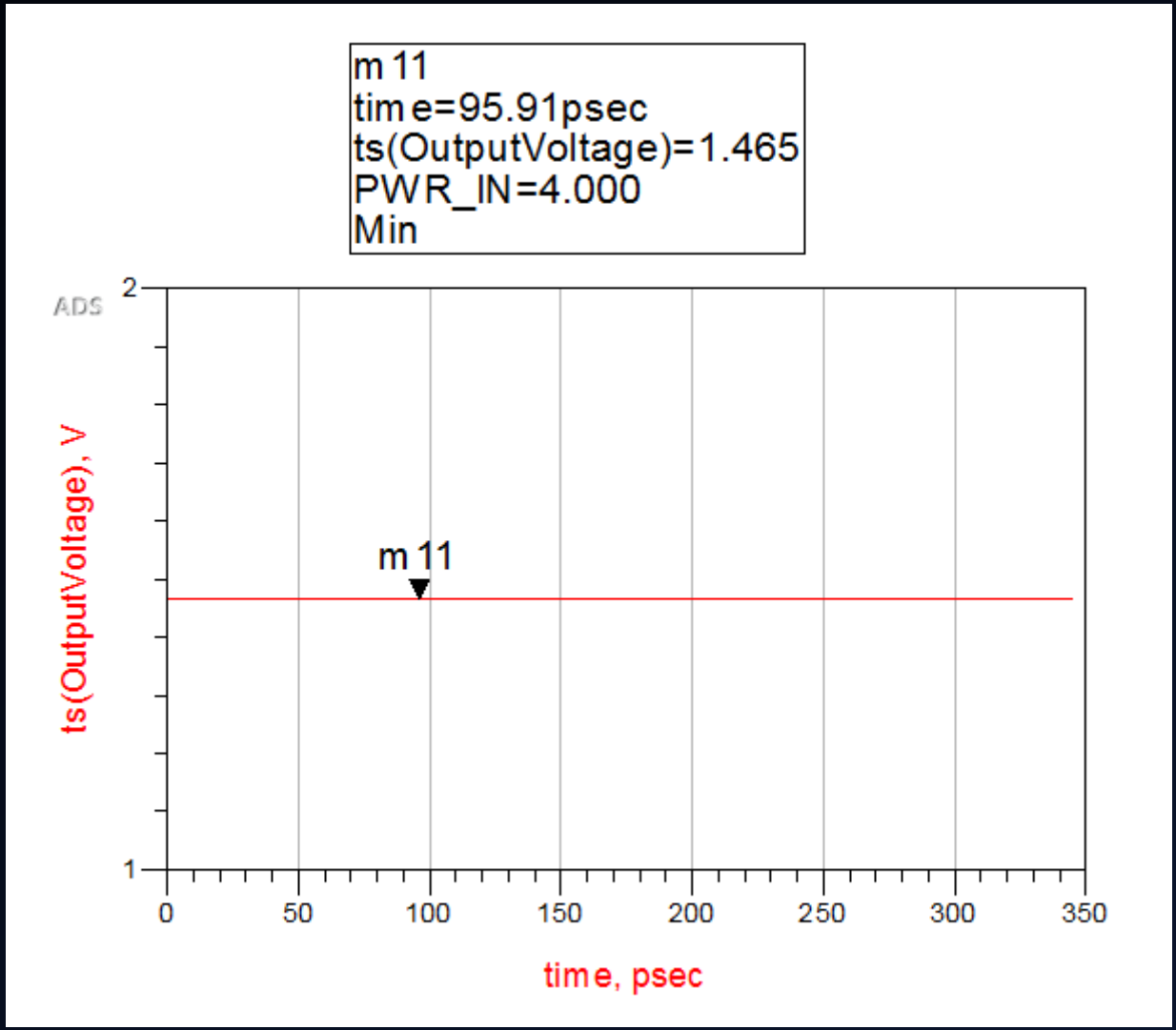
Simulation Results Not As Expected

- The simulation of this circuit could never reach the proper output voltage of between .9V and 1.8V.
- After researching, the design of a simplified 1 stage charge pump with a second diode doubled the voltage.
- Positive half cycle charges Diode1 and Negative half cycle charges Diode2. As time goes on less time is needed to keep it charged.

Half Stage Charge Pump Design To Boost Voltage



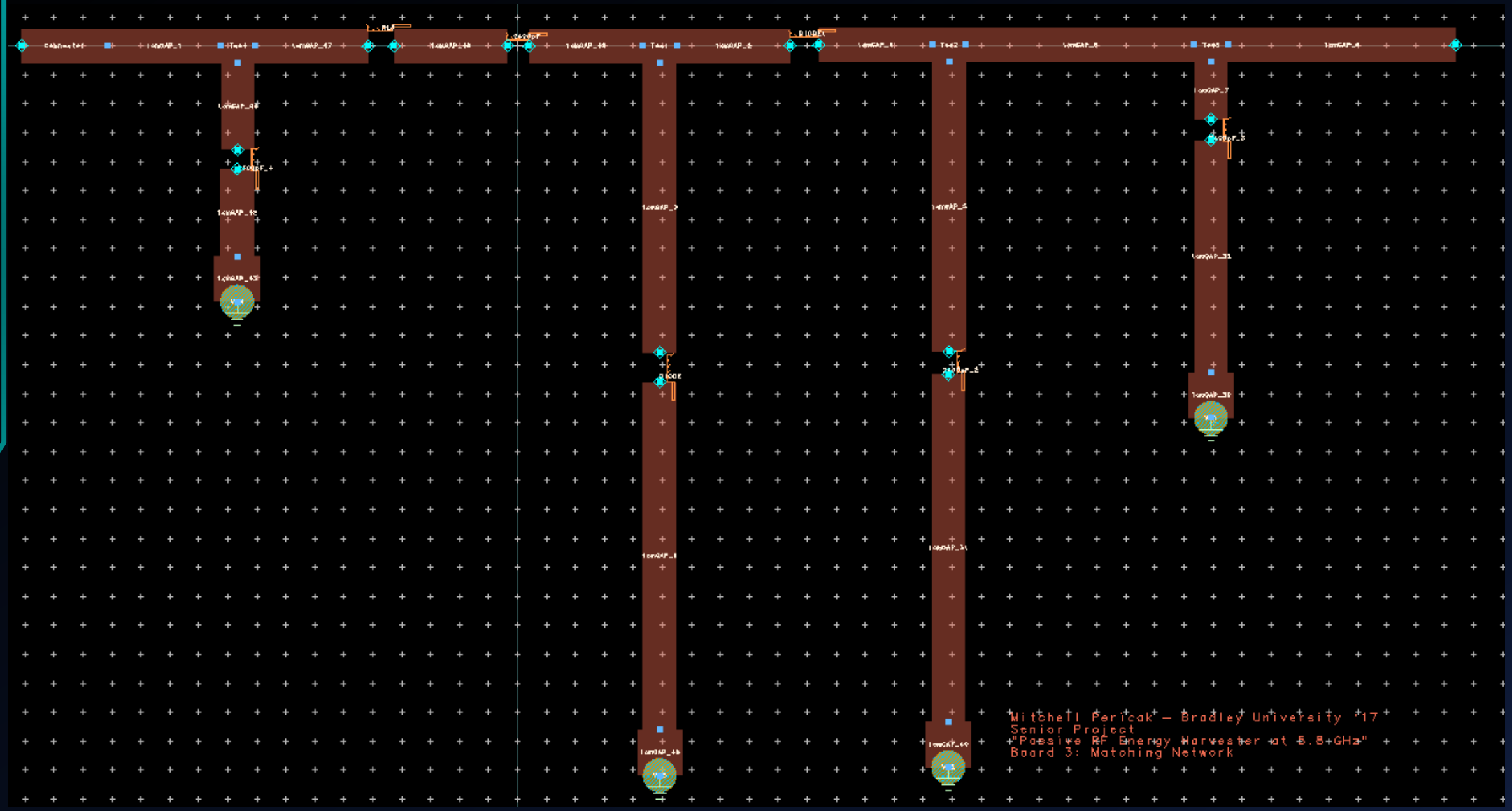
Testing & Simulations



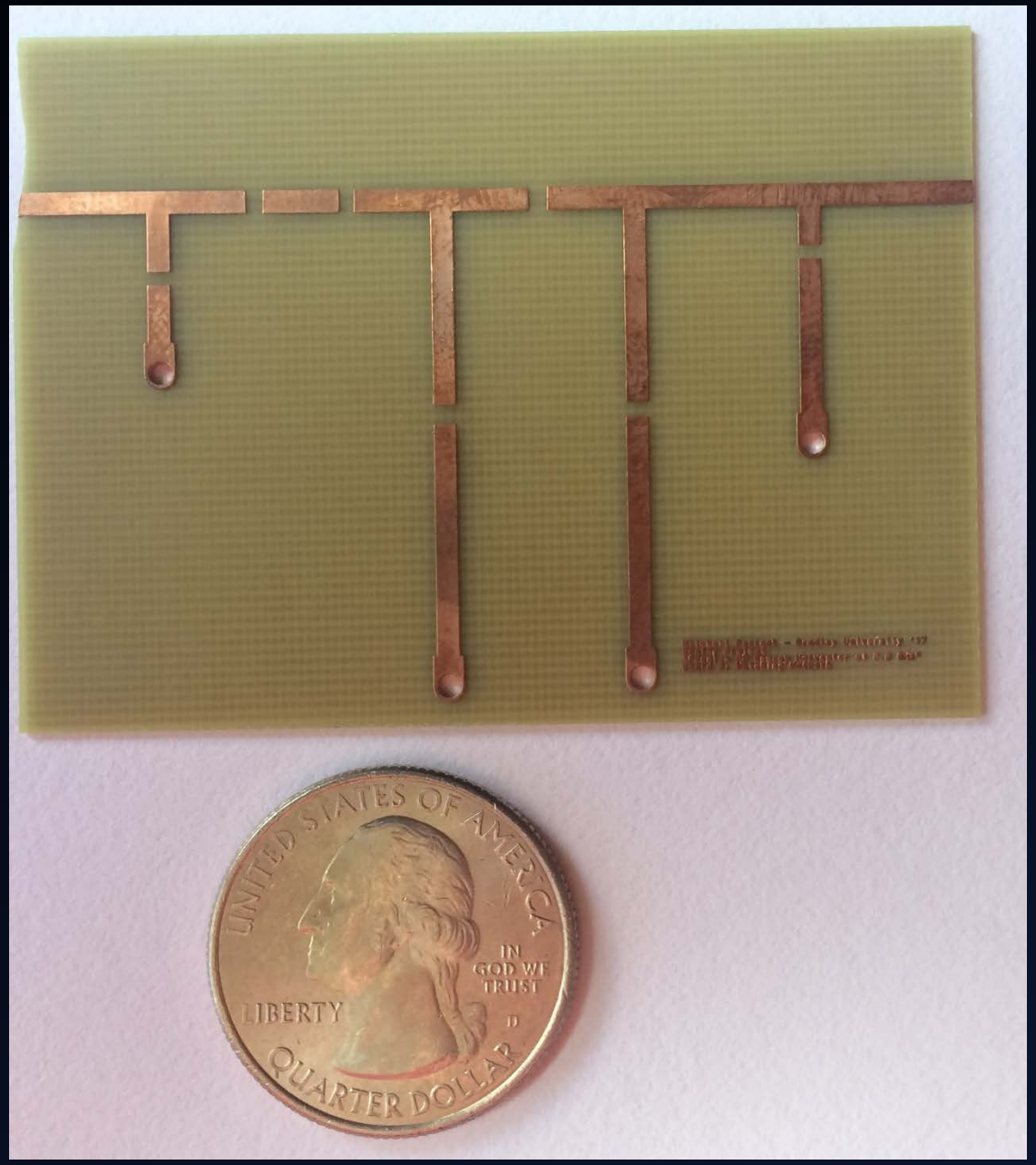
3 Designs to be made after this conclusion

- Circuit Without Matching Network (SMA EDGE)
- Circuit With Matching Network (SMA EDGE)
- Circuit With Matching Network With On Board Charge Pump

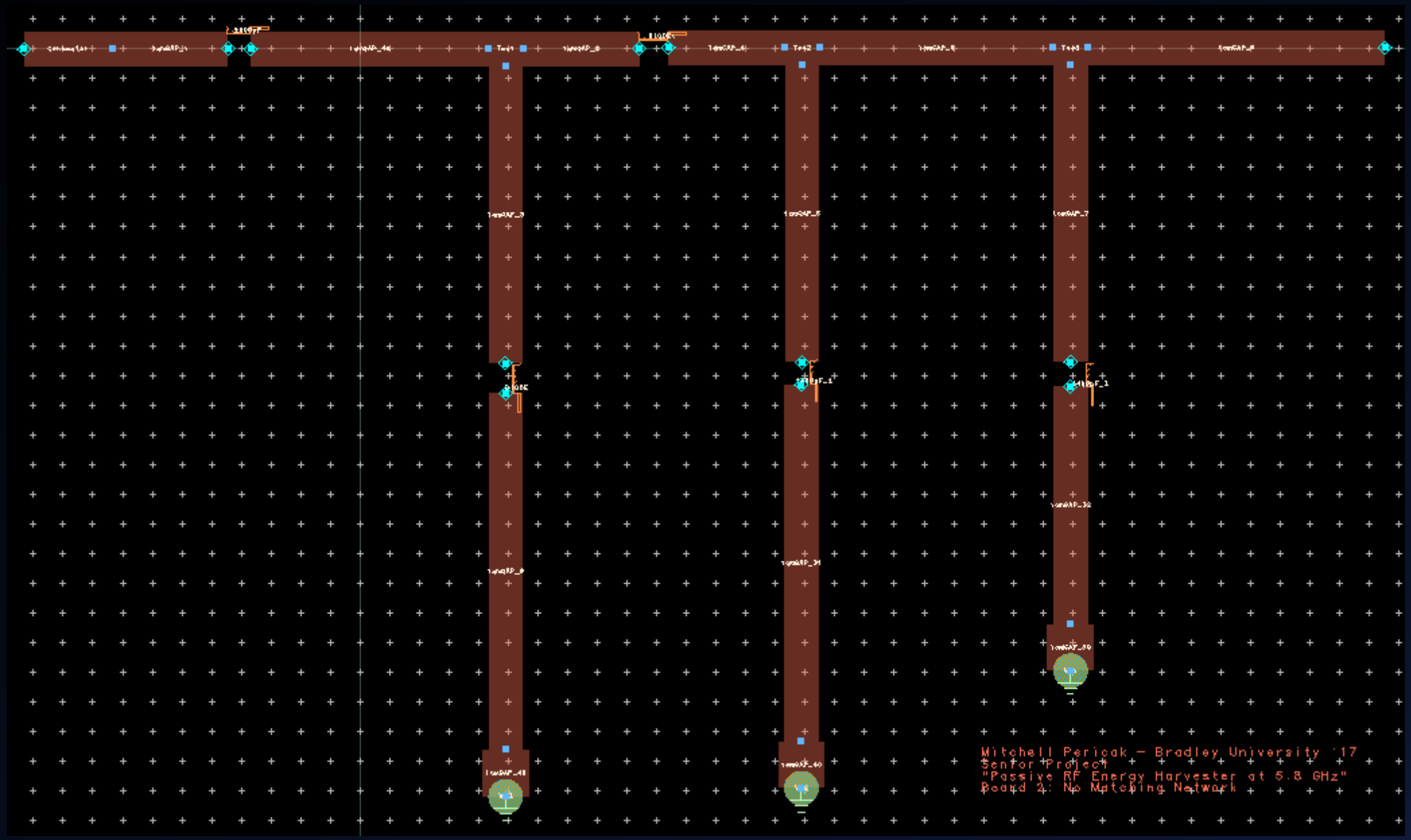
Layout 1 – With Matching (SMA ENDS)



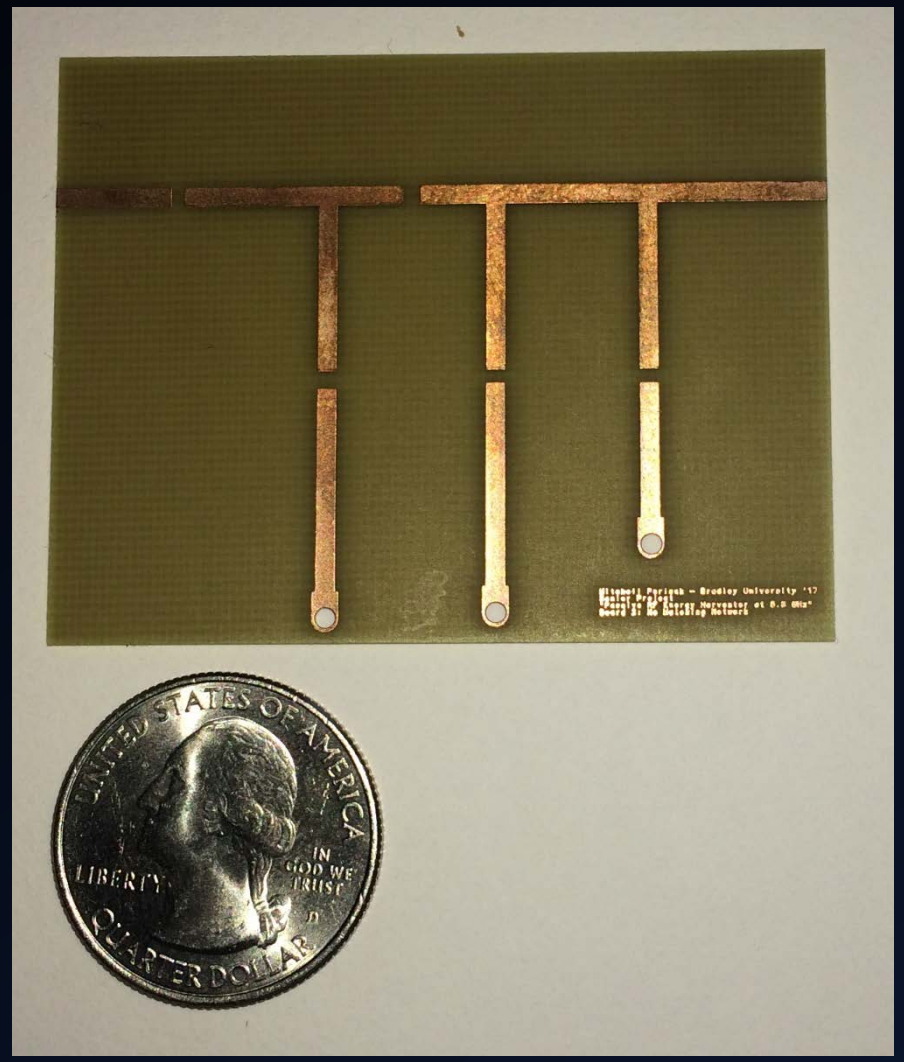
Layout 1


UNITED STATES OF AMERICA
IN GOD WE TRUST
LIBERTY
QUARTER DOLLAR

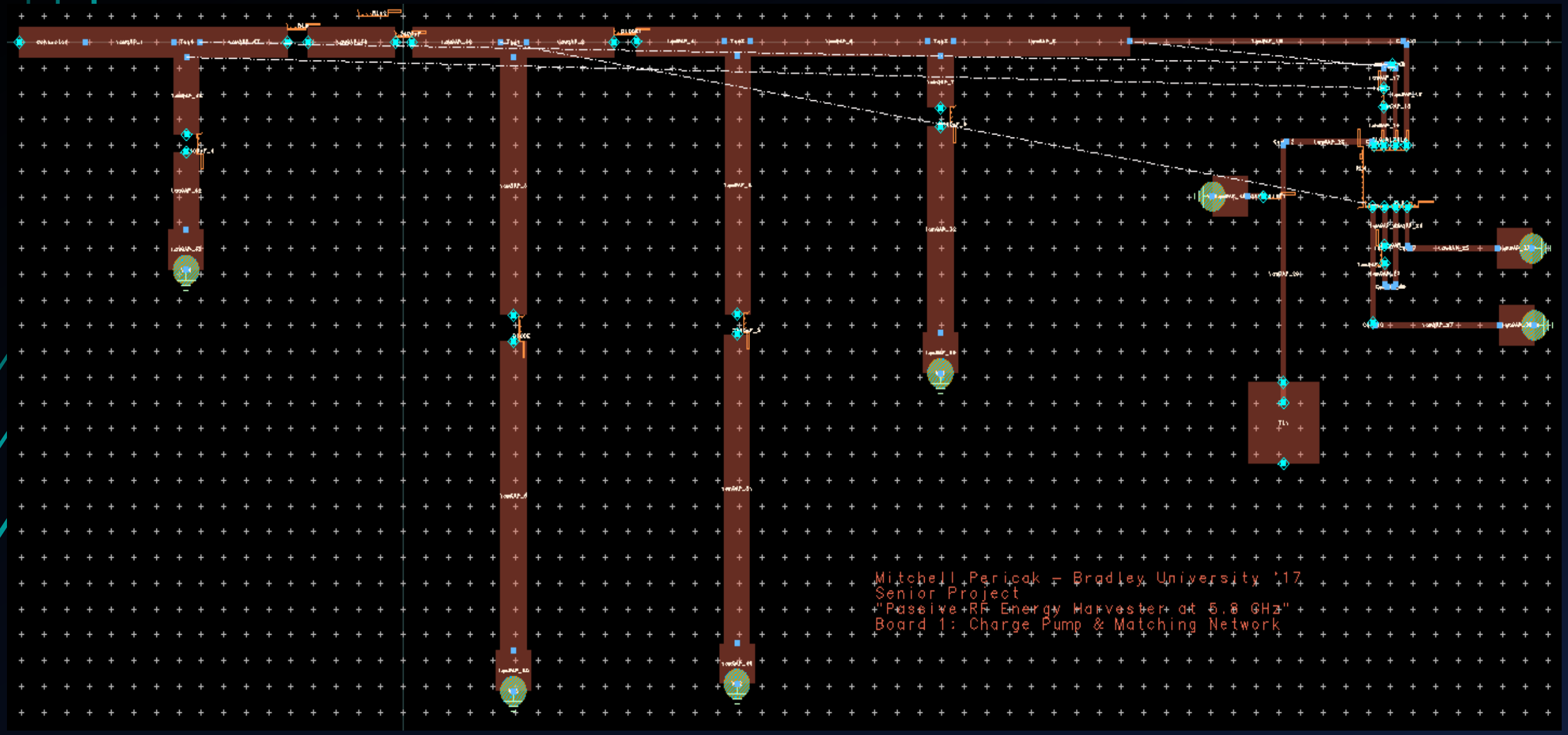
Layout 2


Mitchell Pericak – Bradley University '17
Senior Project
"Passive RF Energy Harvester at 5.8 GHz"
Board 2: No Matching Network

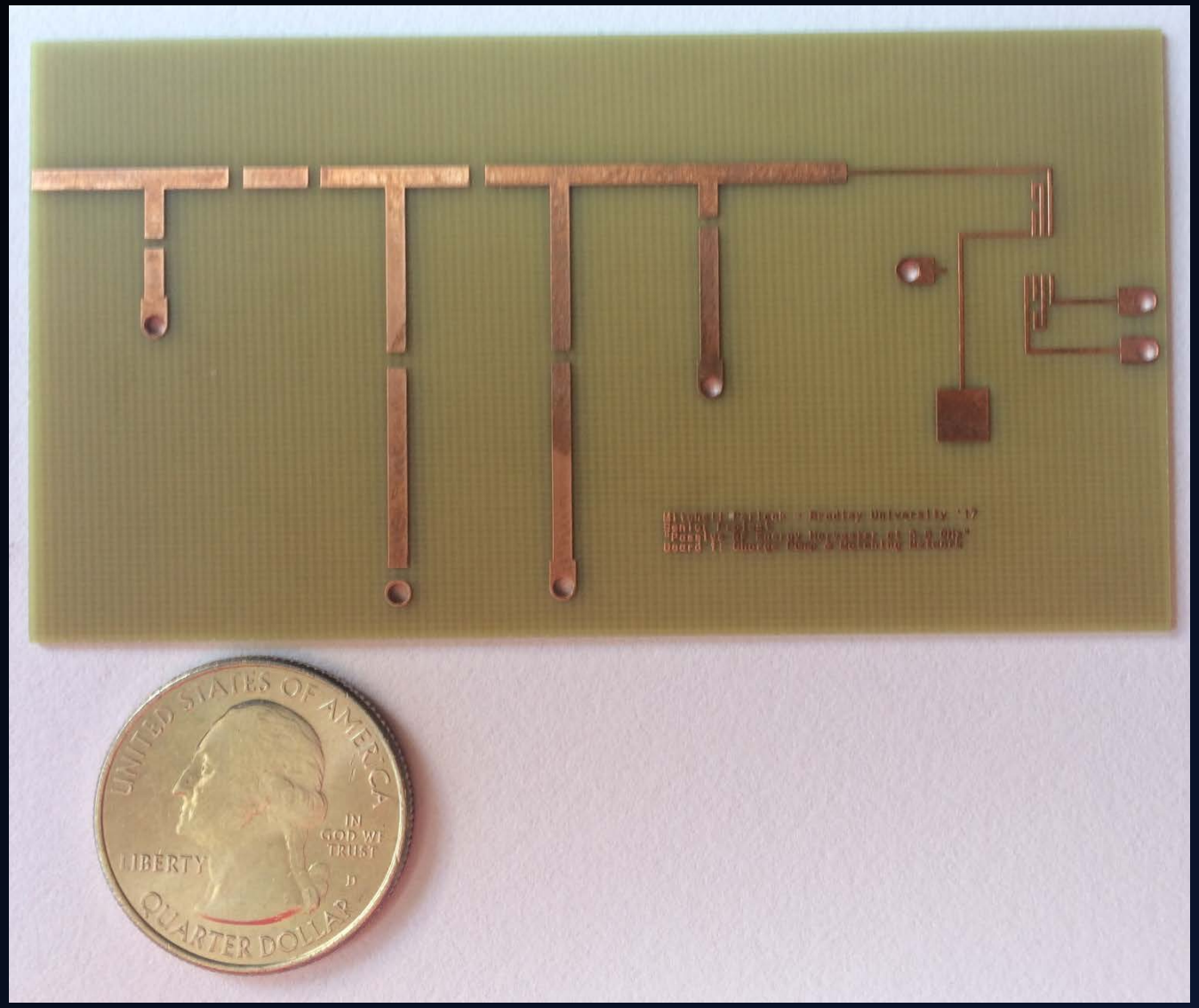
Layout 2


UNITED STATES OF AMERICA
LIBERTY
IN GOD WE TRUST
QUARTER DOLLAR

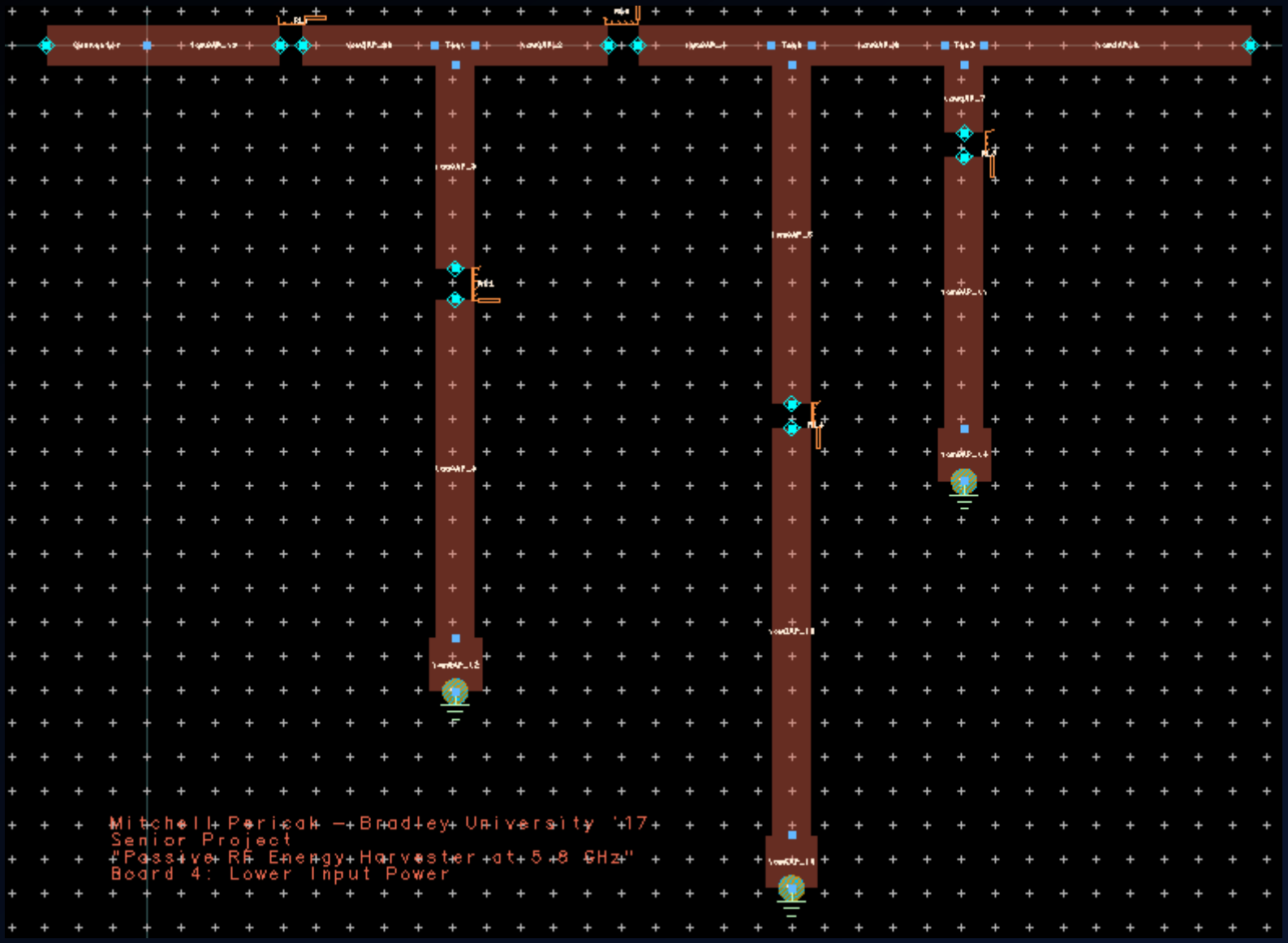
Layout 3


Mitchell Pericak - Bradley University '17
Senior Project
"Passive RF Energy Harvester at 5.8 GHz"
Board 1: Charge Pump & Matching Network

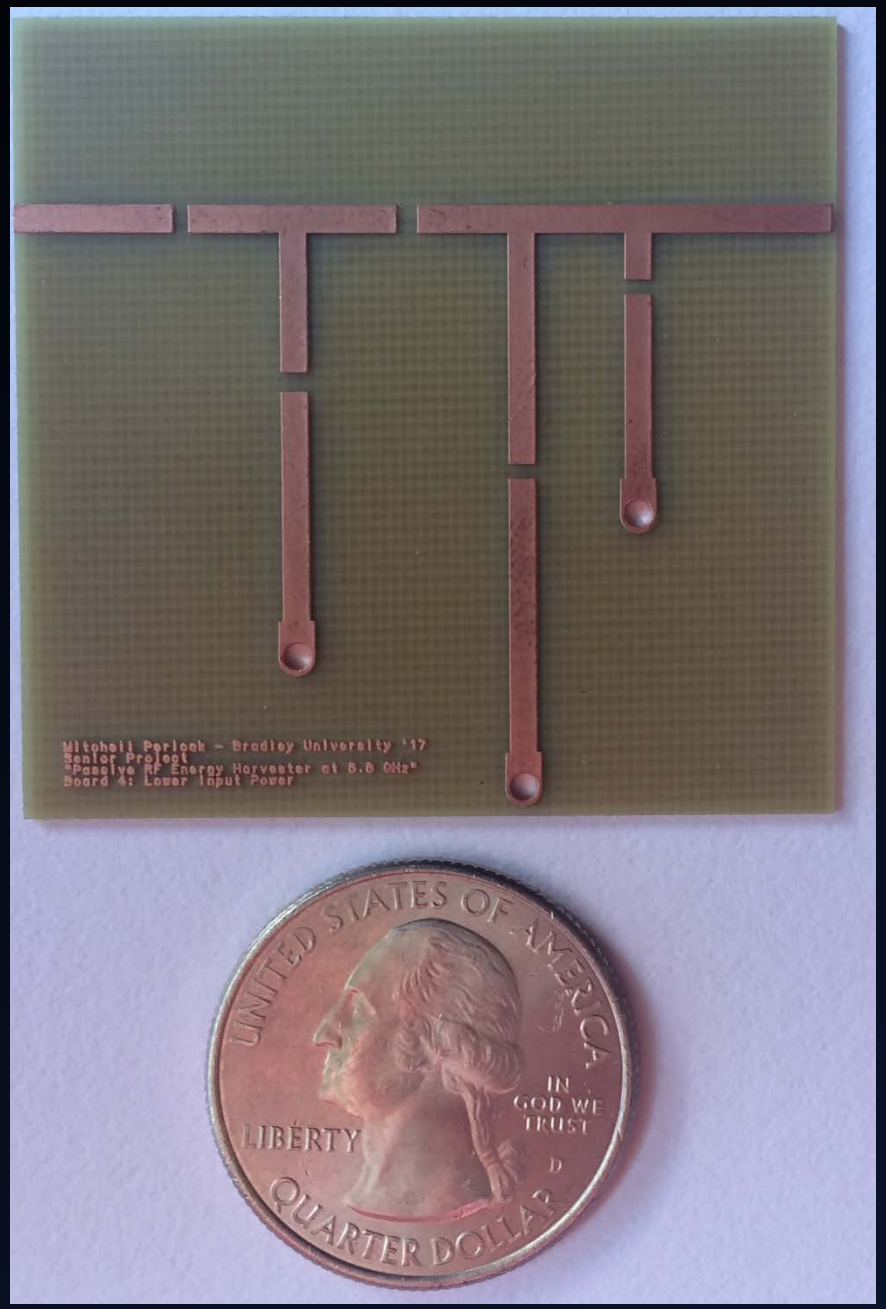
Layout 3


UNITED STATES OF AMERICA
IN GOD WE TRUST
LIBERTY
QUARTER DOLLAR

Layout 4


Mitchell Pericak - Bradley University '17
Senior Project
"Passive RF Energy Harvester at 5.8 GHz"
Board 4: Lower Input Power

Layout 4


Mitchell Perlock - Bradley University '17
Senior Project
"Passive RF Energy Harvester at 5.8 GHz"
Board 4: Lower Input Power
UNITED STATES OF AMERICA
IN GOD WE TRUST
LIBERTY
QUARTER DOLLAR

Testing

- Boards came in, waiting on capacitors to arrive.
- Test will consist of no antennas with transmission line from the signal generator into the circuit, allowing an easy variation of input power.
- Board with shortened microstrip is expected to perform the best.
- Efficiency will be analyzed at the end.

Future Work

- Optimization of microstrip lengths to have lowest input power with highest voltage and current output.
- Research into a matching network that improves the circuit.
- Power sensors and small devices to show a true proof of concept.

References

- Sanchez, Sergio, Tyler Hoge and Elie Baliss. *Wireless Power Transfer System*. Senior Project. Peoria: Bradley University, 2014. Report.
- Vyas, Rushi, et al. "E-WEHP: A Batteryless Embedded Sensor-Platform Wirelessly Powered From Ambient Digital-TV Signals." *IEEE Transactions On Microwave Theory and Technique* (2013): 2491-2505. IEE Article.
- White, Brandon. *RF TO DC CONVERTER*. Senior Project. Peoria: Bradley University, 2016. Report.

Passive RF Energy Harvester at 5.8 GHz

MITCHELL PERICAK ’17
BRADLEY UNIVERSITY
DEPT. OF ELECTRICAL ENGINEERING

ADVISORS: DR. BRIAN HUGGINS & DR. PRASAD SHASTRY

BRADLEY University
Department of Electrical
and Computer Engineering