**Motivation**

In recent years, advancements in technology have made it increasingly important to develop dependable wireless power solutions for low power devices. Although developments in battery technology have increased the reliability of many battery chemistries, the limited lifetime of these devices results in the necessity for monitoring and replacement. In order to mitigate this issue, it is necessary to develop a compact, low-cost system that has the ability to recharge batteries from a wireless energy source.

**Approach**

Ambient radio frequency (RF) energy is abundant in the environment as a result of many high-frequency technologies that make use of the RF band, which encompasses signals ranging from 3kHz to 300GHz. RF energy harvesting seeks to capture ambient RF energy by means of a receiving antenna, and then convert this energy to useable DC power. Most existing RF energy harvesting topologies follow an approach similar to the one shown in Figure 1.

**Antenna Design**

Design of an antenna for an RF energy harvesting circuit requires selection of a specific frequency or frequency band. The parasitic-array microstrip antenna shown in Figure 2 targets both the 2.4 GHz and 5 GHz Wi-Fi bands.

**Processing Circuitry Design**

The direct element of the antenna feeds the processing circuitry, which is shown in Figure 3. The output of the TI bq25504 “Ultra Low-Power Boost Converter With Battery Management for Energy Harvester Applications” has been designed to provide an output voltage of 3.2V for the purpose of charging a Lithium-Ion battery.

**Testing**

Proof-of-concept testing of the RF energy harvester was performed with a 470 μF capacitor at the output instead of a Lithium-Ion battery. The capacitor was completely discharged at time zero and the circuit was placed in an environment where ambient 2.4 GHz Wi-Fi signals were present. The output voltage across the capacitor was measured over the course of 70 hours. The RF energy harvester with the testing capacitor is shown in Figure 4.

Figure 4 displays the results from testing the RF energy harvester. The data is indicative of an exponential recovery function, as is expected for a capacitor charging curve. The plot reveals that the capacitor had reached saturation at 50mV after approximately 50 hours of charging.

While the output of the RF energy harvester did not reach 3.2V, the required voltage to charge the selected Lithium-Ion battery, the test results verify the ability of the circuit to harvest ambient RF energy. While this circuit demonstrates proof-of-concept, many improvements must be made in order to make it a valid solution to effectively charge a Lithium-Ion battery. Potential modifications to the design include improved impedance matching between the antenna and the circuit, optimized antenna design to increase the received power, and refined RF circuit design to minimize losses and reduce the negative effects of trace parasitics.

**References**
