ECE 4370 Project: 5.8 Ghz Charge Pump

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I. Introduction

Continuous RF signals continue to pervade in today's world that can potentially be used as a minor source of power given the conditions of harvesting. One of these methods of harvesting is the charge pump design which collects and scavenge RF signals which creates a potential high output voltage that can power small devices such as LEDs. An obstacle for the charge pump is to convert a AC input signal into a DC signal for a LED. To do this, rectifiers that include passive components such as schottky diodes and capacitors are used.

II. Charge Pump Design

A. Topology

The charge pump circuit being used is a AC to DC converter for the antenna. The main requirement of this circuit is to maximize voltage conversion efficiency by using multiple stages of shtockky diodes and capacitors [3]. The charge pump design was devised as a 3-stage charge pump, but a four stage charge pump was made in case the three stage did not generate enough voltage to drive the LED to the turn on. The reason behind this design is because a 3-stage design provides sufficient current and voltage to light up the LED[4]. A 4-stage design provides a high output voltage, but low current which would not be enough to light up the LED. The schematic layout of 3-stage charge pump design can been seen in **Figure 1**.

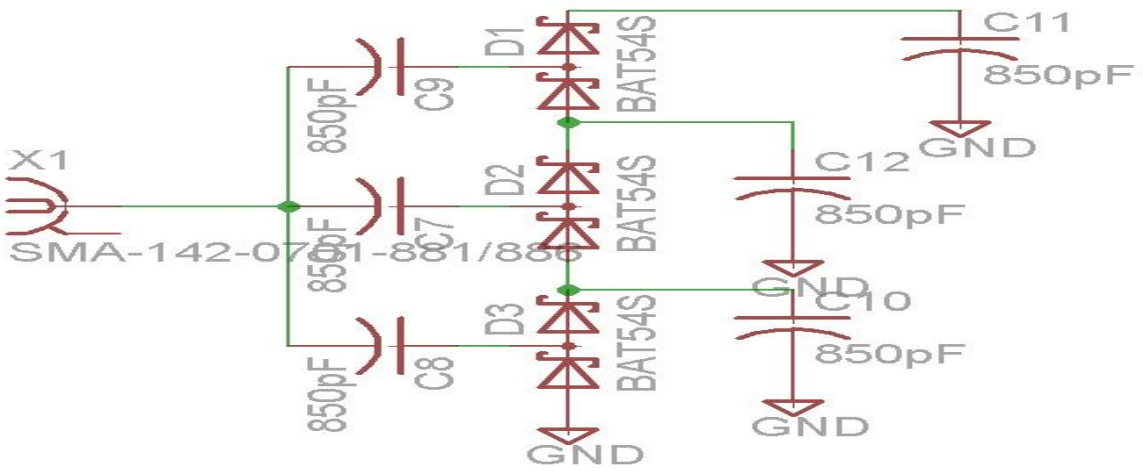

Figure 1. Charge Pump Schematic

B. Calculations

Assuming the peak voltage 5.8 GHz RF signal is fed through through the SMA cable and split into several cables into 820pF capacitors, which adds to the voltage wave. The voltage then enters a set of shtoky diodes that Converts the AC signal into a DC signal, because the woltage peak is needed to turn on

the diodes[2]. The number of stages will create the overal voltage sent to the LED. The observed output is calculated by equation 1.

$$VDC = N\,(VA - VT)$$

N is the number of stages, VA is the the peak voltage from the SMA cable, and VT is the the turn-on voltage of each diode. To achieve the LED turn-on voltage of 1.8 V [] using Schottky diodes with VT = 0.5 V. Two stages are needed to fulfill the wanted voltage. Three stages was chosen because the the two stage assumes that there is perfect matching between the diodes and the antenna. Thus the assumption of transmission loss is given and a three stage charge pump is selected [1].

C. Components

The components used for the charge pump are listed in **table 1** the parameters of the PCB in **table 2**. The EagleCad layout for the charge pump is shown in **figure 2**.

Table 1. Charge Pump Components

Component	**Manufacturer**	**Model #**
LED	CML	CMD28-21
Schottky Diode	Avago	HSMS-2862
Capacitors	Mouser	C06BLBB2X5
SMA connector		30 mil board side mount

Table 2. PCB specifications

Substrate Thickness	32 millimeters
Relative Permittivity	4.2@6Ghz
Conductivity	$5.813*10^7$ S/k
Metallization thickness	1 mil

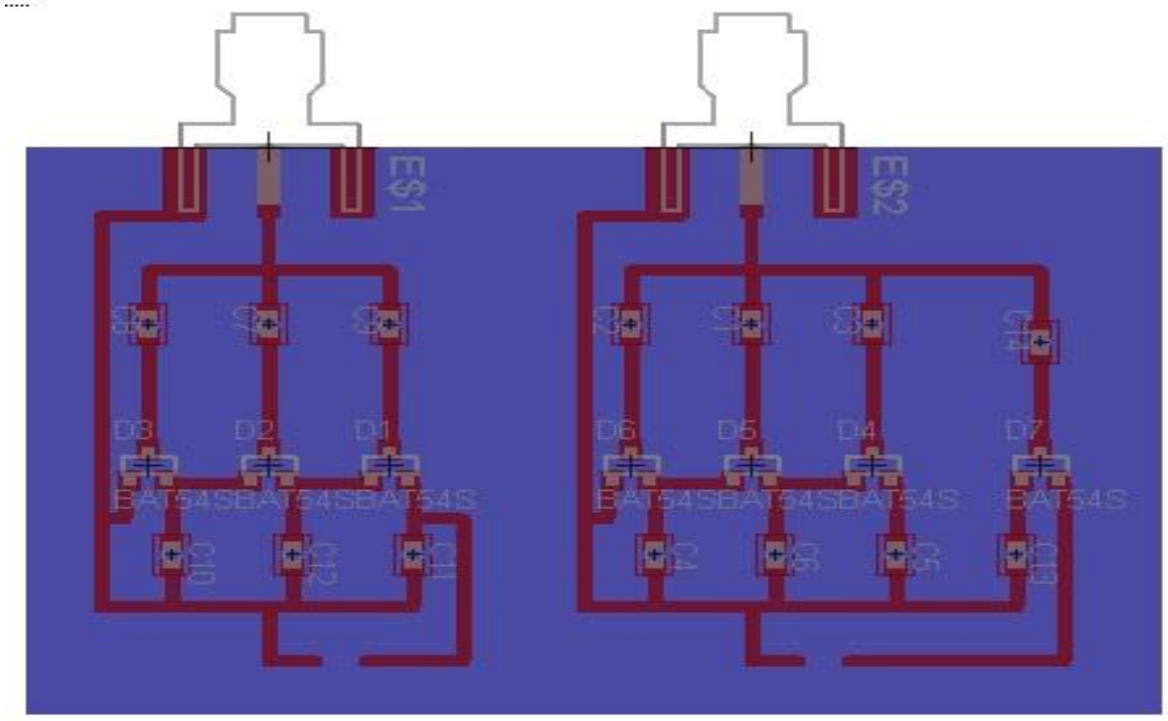

Figure 2. Three and Four Stage Board Layout

III. Fabrication and Results

Figure 3 shows the finished charge pump construction. The charge pump was unsuccessful in our trials, but due to unknown errors we were unable to light the LED up. LED did light up on when directly feeding voltages.

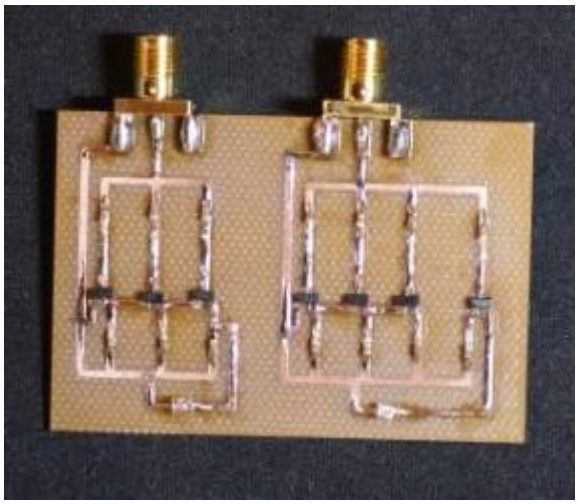

Figure 3. Charge Pump Construction

IV. References

[1] J. Parks *et al.*,“ 5.8 GHz RF Energy Harvester,” unpublished.
[2] P. Speirs *et al.*,“Project 3: 5.8 GHz Energy Harvester,” unpublished.
[3] S. Hsin *et al.*,“ECE 3631 Project 3: 5.8 GHz Energy Harvester,” unpublished.
[4] M. Costley *et al.*,“5.8 GHz Charge Pump Receiver,” unpublished.