Non-linear Energy Harvester utilising three magnet vibration

Hardware Design

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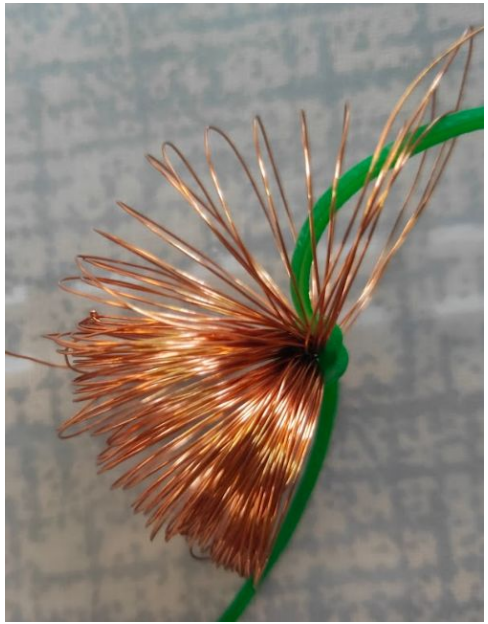
Design 1.0

Materials used

DT830D LCD Display Digital Multi-meter Digital Multimeter (Yellow Color)

LifeKrafts Ceramic/Ferrite Strong Magnets| Size: (18x5) mm, Pack of 10 | Industrial Powerful [Grade 11] Magnets, Refrigerator Magnets, Magnets for Crafts, DIY Projects, Home, Office, School etc.



ART IFACT 20 Meters Enameled Copper Wire - 34 Gauge (0.23 mm Diameter) - 99.9% Pure Copper Wire - Winding Wire - Magnet Wire

Channel file

This is the weaving harvester.

The middle moving part comprises of five magnets stacked on top of each other.

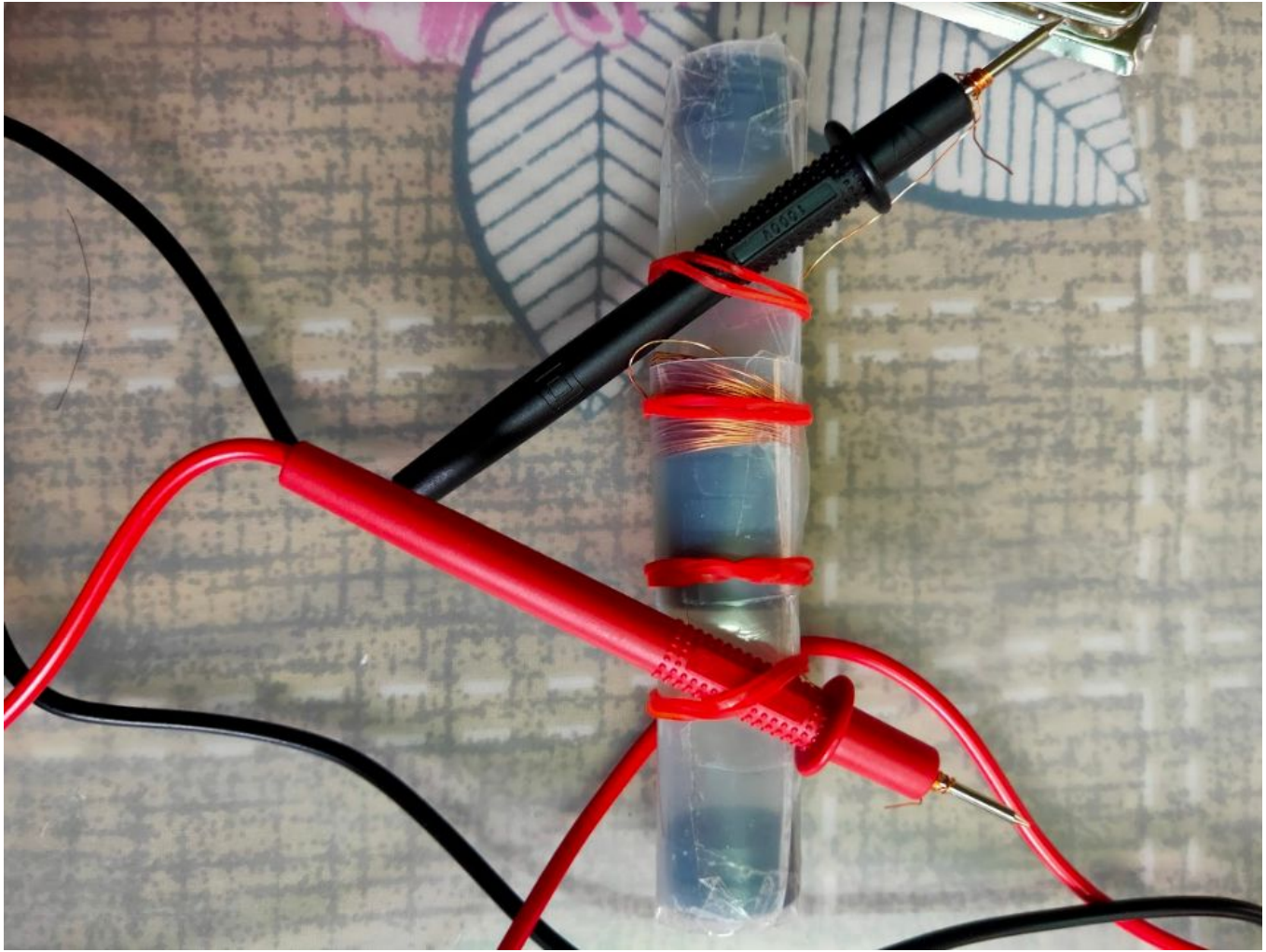
The stopper at the ends of the tube is made up of two magnet stacks.

Vibration Mechanism

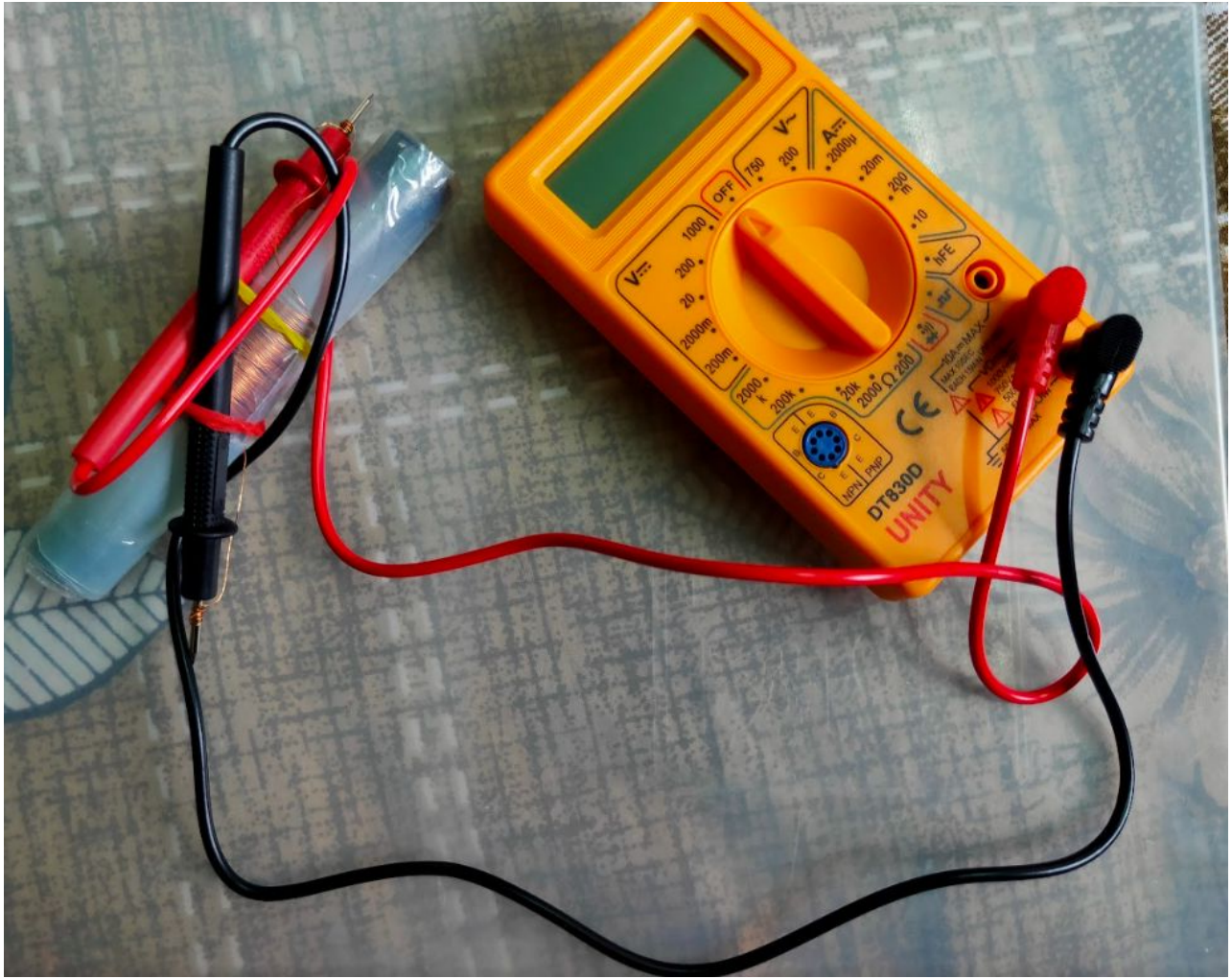
Slo-motion

Coil is wrapped on the outside of the enclosure such that it covers the middle part

Below is the coil that was wrapped round the enclosure.



Complete weaving harvester


OFF
750
200
1000
200
20
2000m
200m
2000
200k
20k
2000
200
20m
200
10
hFE
DT830D
UNITY

Final setup

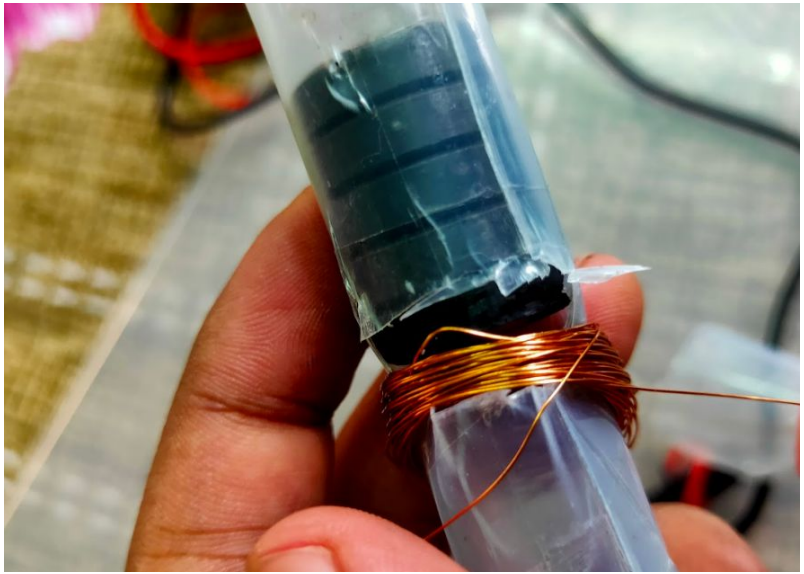
Voltage generated

Observation

1. Max voltage generated is about 3.3 mV

2. Reason for low voltage maybe weak magnet, shorting of the coil or coil topology

Design 1.1



Design 1.1 had a problem. The coils were wrapped round the channel file and hence the cutting of flux lines were hindered. A window slit is cut so that the magnets can directly over see the coil and flux cutting is more accurate.

Observation:

Design 1.2 has increased voltage. Max voltage is 4 mV.

Design 2.1

Design 2.1 is the first iteration on the idea that I proposed in previous presentation. The image on the left is the upper part of the right hand side design. Same polarity faces of the magnet are attached to the spring facing each other, to increase the repulsive force. Thus repulsive force is the addition of the spring as well as magnetic force.

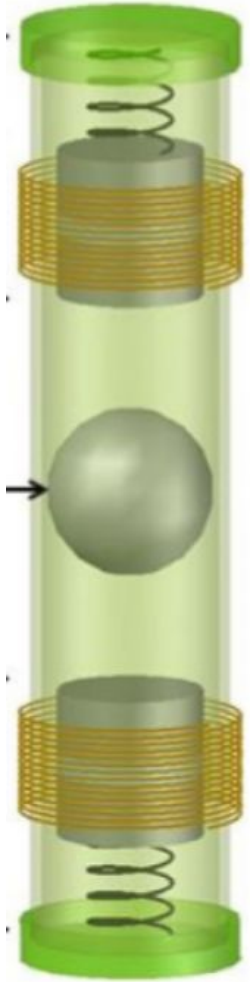
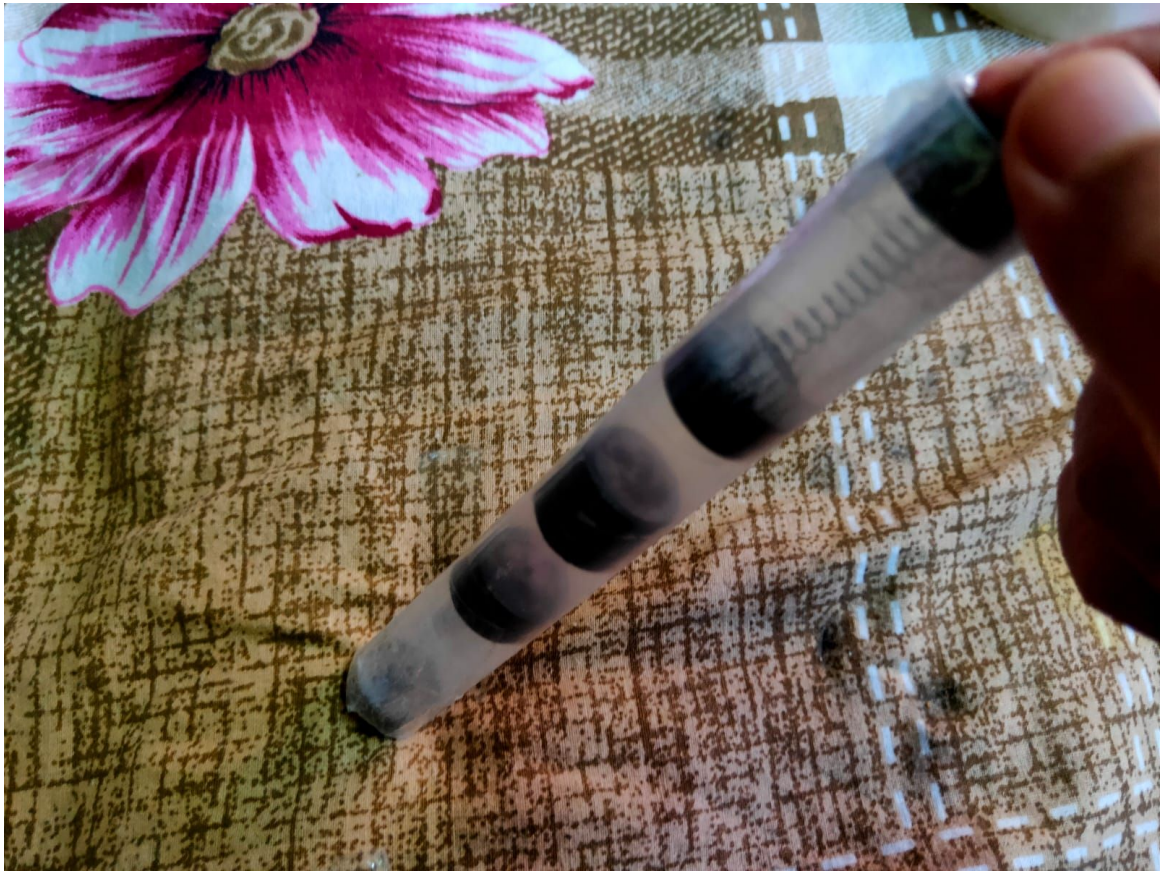
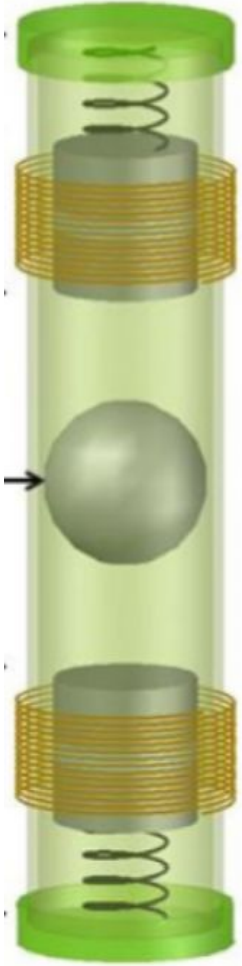
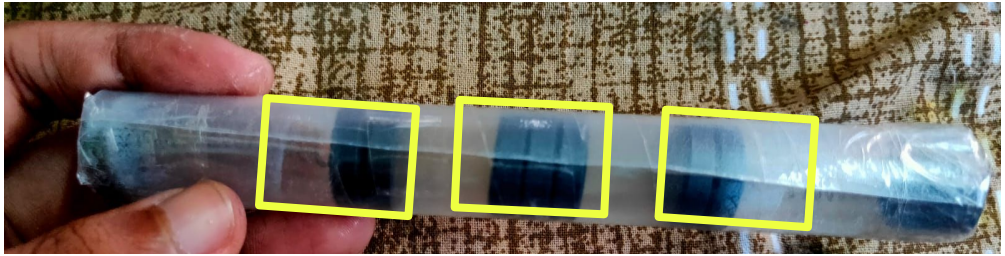


Image shows how the spring magnet setup is placed in the tube



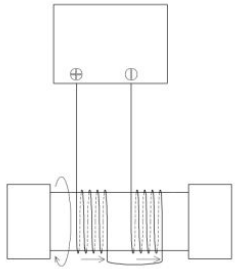
This is the complete setup. There are total 5 separate magnet components of which only one is freely moving and two are freely vibrating. Now we will attach surrounding the vibrating and freely moving magnets





Coils will be wound around the yellow boxes

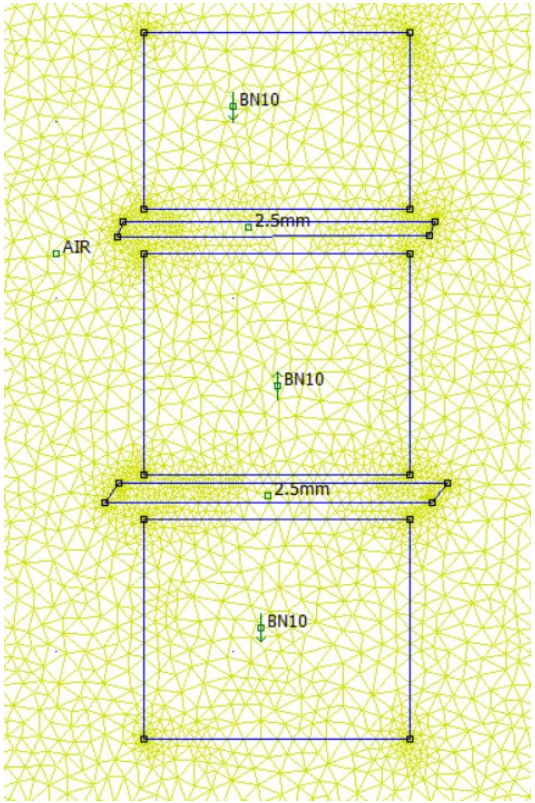
Figure 5. Phase-matching connection of neighboring solenoids by reversed series wiring.

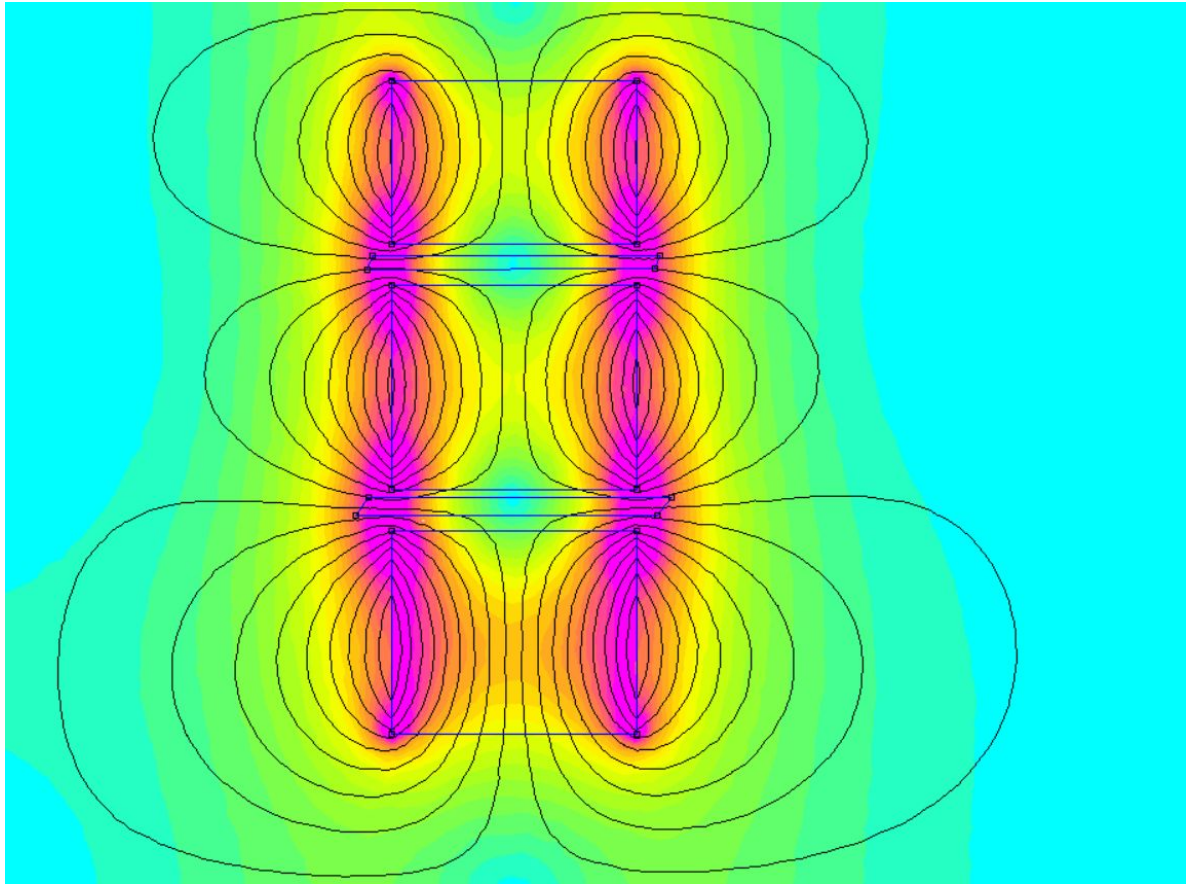


In the Sensors paper the coil was wound in the above fashion. I have used a similar winding. The setup is shown in the right.

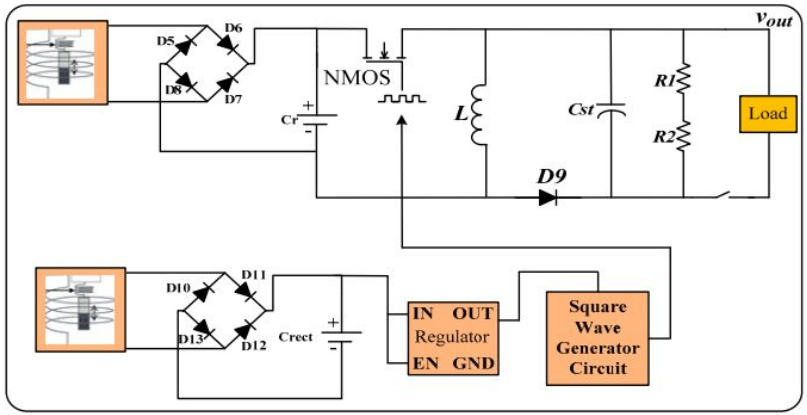
This is the Final Setup for Design 2.1. The voltage generated is similar to Design 1.2. Maximum voltage generated being 3.2 mV

Magnetostatic Simulation

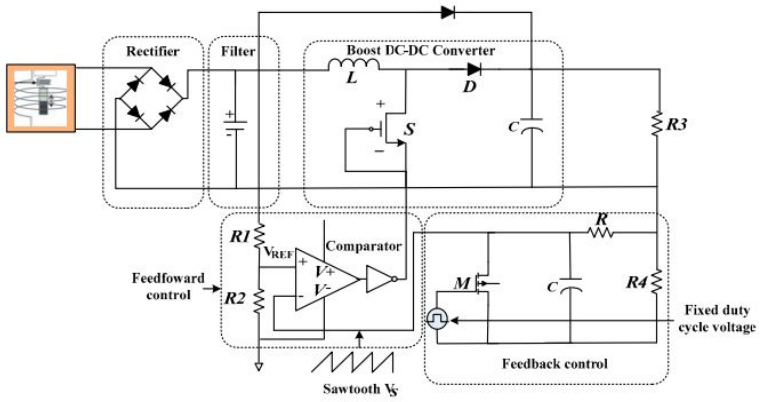




Harvesting Circuits



SSHI



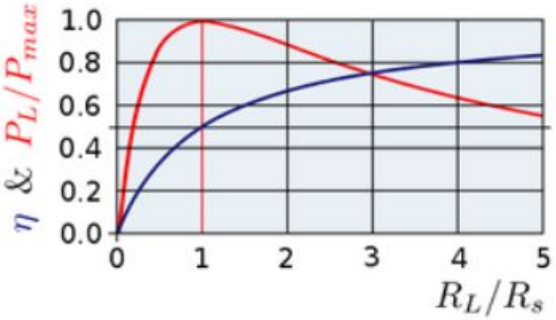
Boost Converter

I haven’t found any literature comparing the benefit of SSHI over Boost Converter and vice versa. Due to this reason I am going forward with SSHI circuit for harvesting

I put up this question in Electronic Exchange and this was one of the answer

Since the Maximum Power Transfer (MPT) theorem is based on matched conjugate impedances and neither block diagram shows any means of tracking this by measuring current, I'd say that neither solution is optimal for dynamic sources where source impedance changes with energy available.

Simply put when source/load resistance ratio = 1, you can transfer the maximum theoretical power. However there may be thermal issues.



The red curve shows the power in the load, normalized relative to its maximum possible. The black curve shows the efficiency η.

Papers I am consulting for building SSHI Circuit

https://iopscience.iop.org/article/10.1088/0964-1726/16/6/028/meta

https://iopscience.iop.org/article/10.1088/0964-1726/19/12/125009/meta

https://ieeexplore.ieee.org/abstract/document/7084647

https://ieeexplore.ieee.org/abstract/document/4776514

https://ieeexplore.ieee.org/abstract/document/7776977

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