# Research on Energy Harvesting and Wireless Charging Technology for Internet of Things (IoT) Applications

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## Overview

### Motivation Behind Design:

- Renewable or "green" sources of energy have become a popular alternative energy source outside of traditional means.
- A movement away from the use of batteries in small devices is impactful to reducing waste and pollutants.
- Continuous wireless energy transferred to devices would eliminate the need for human intervention to replace batteries, especially in potentially harmful areas.
- The dependence on batteries or commercial electricity could pose inconvenient or potentially dangerous problems in the event of blackouts or other loss of power.

### Current Options:

- The methods that currently exist for transmitting power wirelessly create large losses and are highly affected by noise.
- Relying on renewable energy sources means relying on discontinuous forms of power generation.
- Renewable energy sources are greatly, if not entirely, reliant on their environmental conditions.
- Methods that use storage rather than direct power application experience capacitor leakage.

### Proposed Solutions:

- This ongoing research intends to build and test a prototype of a typical system that harvests energy from the environment and wirelessly transfers this energy to Internet of Things (IoT) devices.
- A Low Dropout Regulator(LDO) is designed to supply stable voltage for noise-sensitive components.
- Multiple harvesting methods will be used for generating power for more reliable generation.

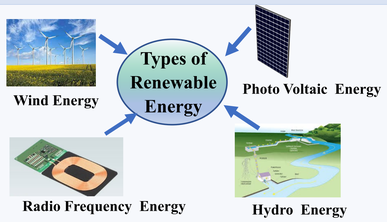


Fig.1. Renewable Energy Sources

## Proposed Setup

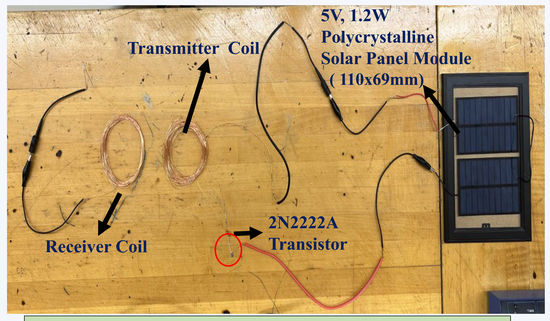


Fig.2. Wireless Power Transfer System

## Experiment/ testing

- The experiment was begun by constructing wireless power transmitter circuit.
- Major components of the transmitter portion of the setup, are the solar panels, transmitting coil, a 2N2222A transistor, and a 4.7kΩ resistor. The transistor is for generating high-frequency AC current across the coil and the coil is generating a magnetic field around it. Transmitter coil was constructed using copper wire (28 gauge), wounded 30 times at a diameter of approximately 6.6cm.
- The receiver portion of our setup was made using the same wire, with the same number of windings and diameter as our transmitter. One light-emitting diode (3.2V, 20mA) was placed in the receiving portion of our setup for the purpose of indicating power transfer.
- Two 5V, 1.2W series connected solar panels are used to transform solar energy to electrical energy.
- The antennas are mounted in a vertical position .

## Results

We recorded some values for this setup. These were taken in direct sunlight on a clear day in the late morning. A clear increase can be seen as the sun continued to rise.

| | Value | ←10AM---11AM→ | | |
|---|---|---|---|---|
| PV Panels | Voltage (V) | 10.1 | 10.61 | 12.9 |
| | Current (mA) | 185.7 | 190.0 | 200 |
| Load | Voltage (V) | 9.7 | 9.95 | 10.2 |
| | Current (mA) | 78.6 | 80.2 | 85.3 |
| | Efficiency | 40.6% | 39.6% | 33% |

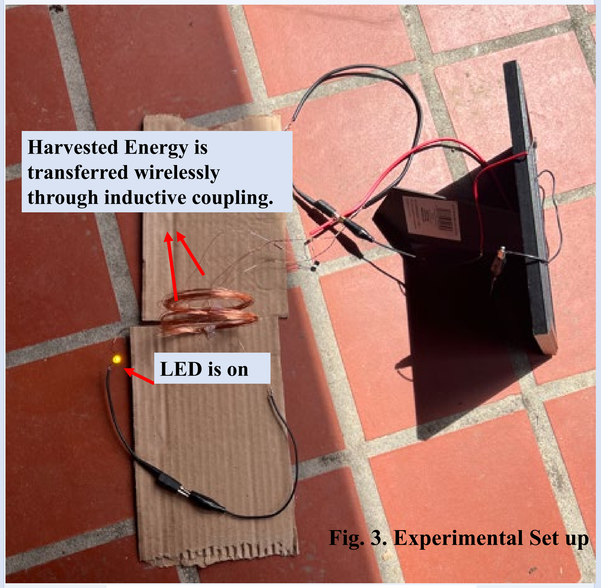


Fig. 3. Experimental Set up

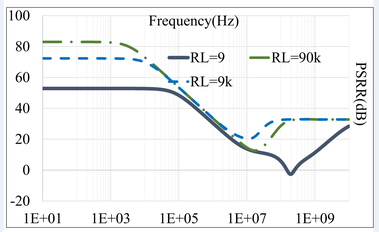


Fig. 4. Power Supply Rejection Ratio (PSRR) of the proposed LDO for different load

A Low dropout regulator is being designed to suppress noise and volatility in the harvested energy efficiently.

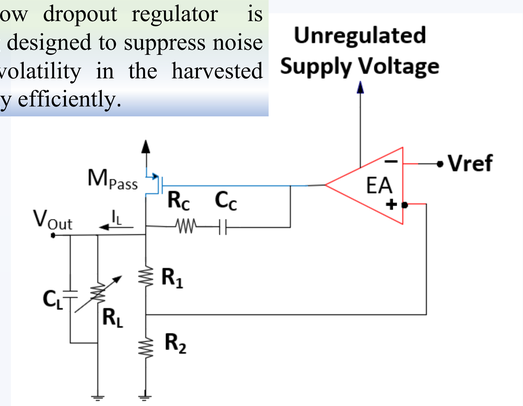


Fig. 5. Block Diagram of Low Drop out Regulator

## Conclusions

- This experiment acts as a proof of concept.
- The two significant drawbacks of energy harvesting are found here: a) The harvested energy is highly receptive to noise and volatility. b) The availability of the harvested energy varies mainly with time in a non-deterministic manner.
- To solve problem (a), a Low Dropout Regulator(LDO) is being designed to supply noise-free stable voltage to the noise-sensitive units.
- To solve the problem (b), multiple energy-scavenging sources will be considered for an uninterrupted power supply to the network.
- The outcomes of this research will be beneficial for off-grid applications such as wildlife management using motion-activated trail cameras, monitoring seismic activity with remote sensors, smart agriculture, etc.

## References

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