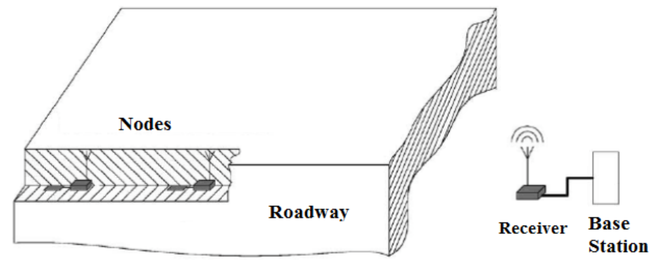
Wireless Embedded Roadway Health Monitoring System (WERHM)



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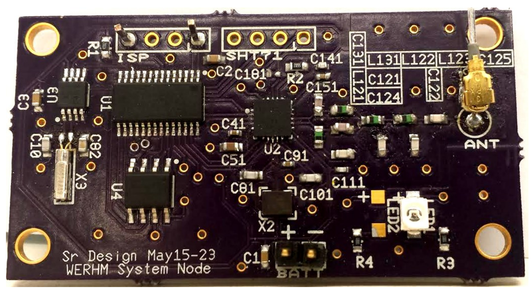
Problem Statement

Structural health monitoring systems evaluate structures for safety without requiring the presence of an inspector. Implementing such a system without wireless communication becomes too difficult, fragile, and expensive to be feasible. A wireless sensor network makes the system low cost, have quick installation times, and high system reliability.

Requirements

Functional Requirements:

- ◊ Wireless communication
- ◊ Accurate timestamps
- ◊ Low power consumption
- ◊ Possible recharging system



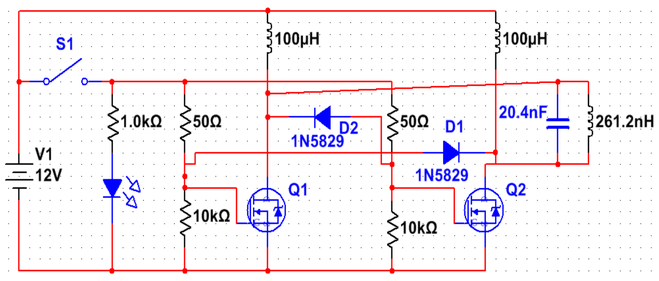
Non-Functional Requirements:

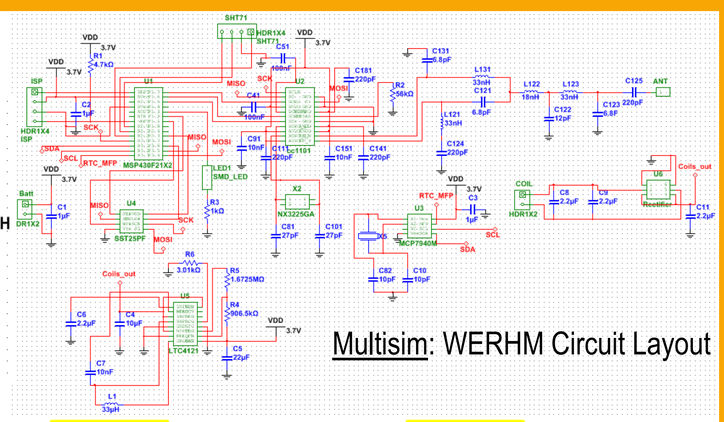
- ◊ User interface at Base Station
- ◊ Easy accessible data collection
- ◊ Safe and easy to use

Circuit Schematics

Multisim: Power Transmitter Royer Oscillator

Resonant Frequency ~ 2.179 MHz

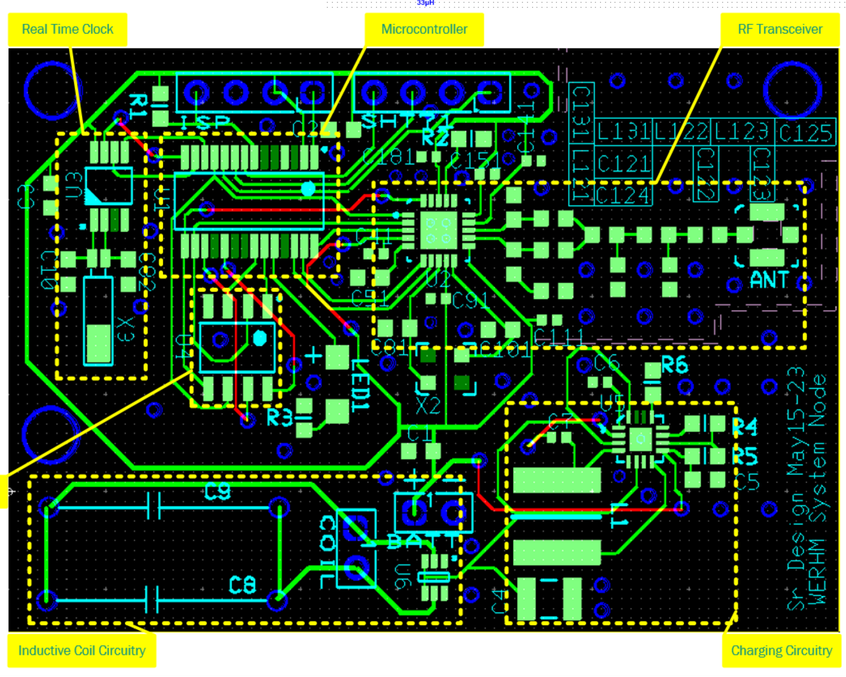




Multisim: WERHM Circuit Layout

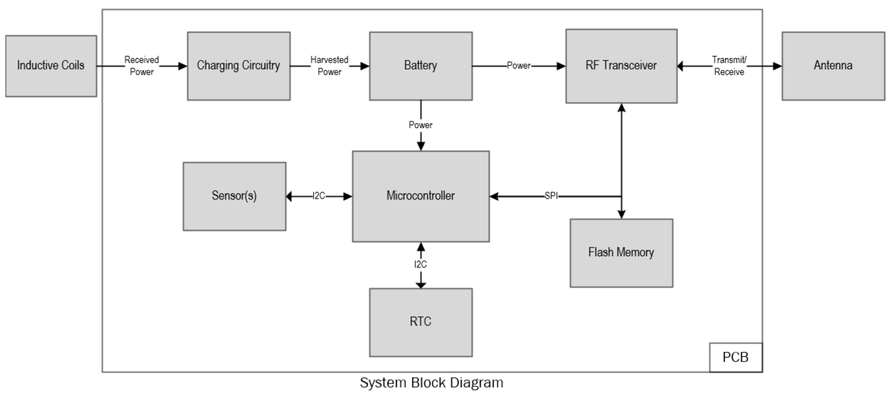
Ultiboard:

WERHM Node



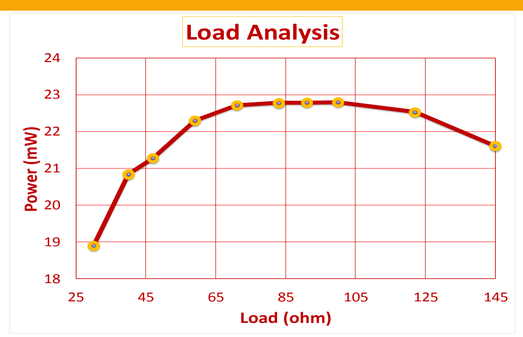
Design Approach

The system was subdivided into two sections: wireless battery charging and communication via RF transceiver. Circuits were created to harvest energy inductively from an external source and to charge a Li-Ion battery which powers the microcontroller. Each node was equipped with a RF transceiver to communicate between one another and the central base station. Because nodes have access to limited power, components were chosen for optimal battery life and software designed with a very low active duty cycle.

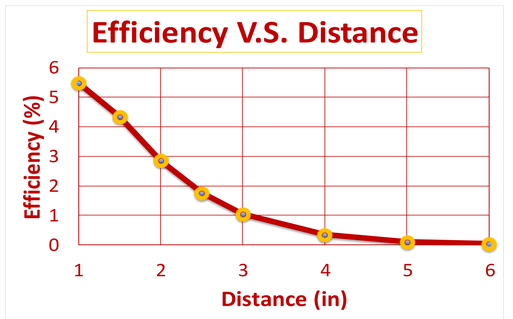


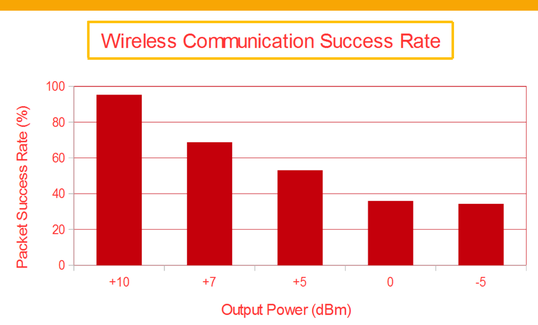
System Block Diagram

Results



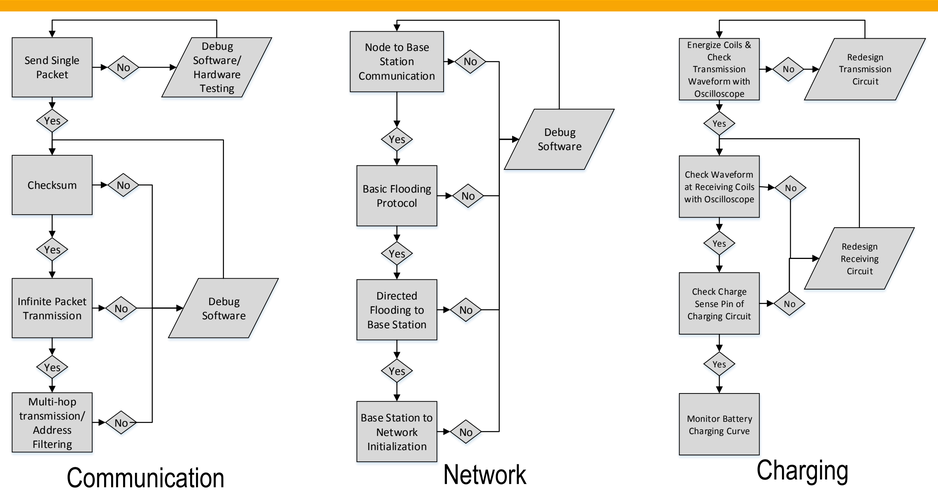
As seen above in the load analysis, the optimal resistive load for the receiver circuit is approximately 80-100 ohms. From the analysis, the following graph was created. With a resistive load of 100 ohms, the following efficiency are given with their respective distances.





Packet success rate was measured during communication tests through concrete at different output powers. Directed flooding routing protocols allow lower success rates for +7dBm and +5dBm to be acceptable.

Testing Procedure



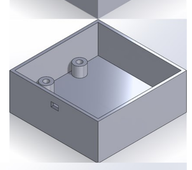
Enclosure

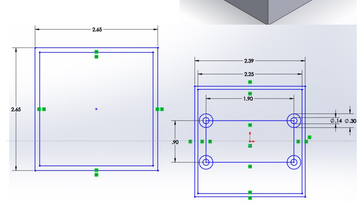
Material: ABS Plastic (Acrylonitrile butadiene styrene)

Two Designs: Charging and Non-Charging

Exposure: Small opening for sensor for indirect concrete measurements

Mesh: Gore-Tex - waterproof membrane that allows the sensor to measure temperature and humidity





Project Applications

WERHM Potential Uses:

- ◊ Airport runways
- ◊ Interstates and Highways
- ◊ Bridges
- ◊ Skyscrapers

This project can be installed in virtually any concrete application.