Parasitic Power Meter

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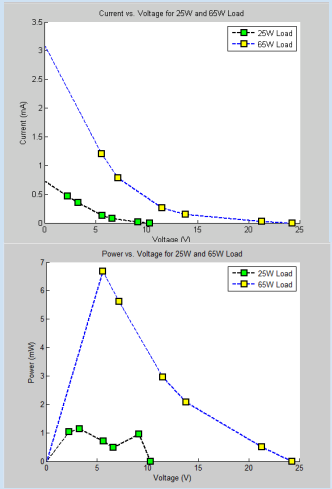
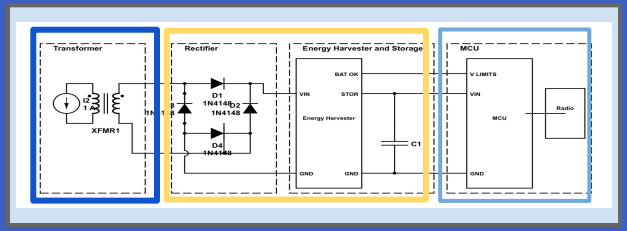
Abstract

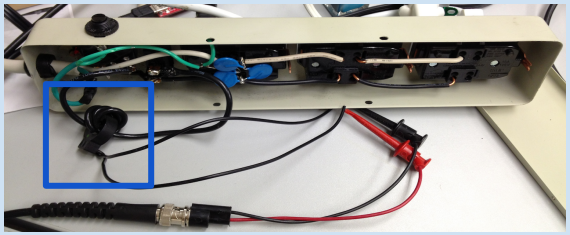
This research project aims to calculate a load by measuring energy harvested from a power cable. The long-term goal of the project is to gather power through a transformer, rectify and smooth the signal, and then pass it through an energy harvesting module. The energy harvesting module will regulate the signal and store it in a bank of capacitors used to power an MCU. The module will also inform the MCU when the acquired voltage is within a specified under and overvoltage range. Each time the MCU is powered up, it will increment a counter value stored in non-volatile FRAM and transmit a packet via radio signal to a base station.

Transformer Circuitry

Implementation: The energy for the system is gathered through a CR2550-G transformer coiled with four loops of the power line in a power strip. The power strip allows for known variation in the system's load.

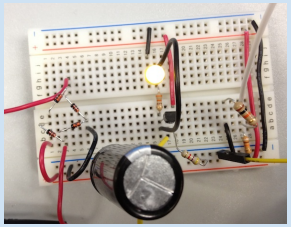


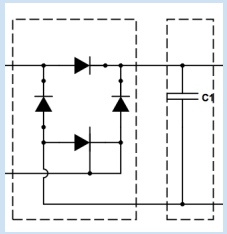




Energy Harvesting and Storage Circuitry

Complications: We chose the BQ25504 evaluation module as our energy harvester because we expected the transformer to provide very low voltages (< 3V); however, we found the voltages to greatly exceed this (>20V possible). This ruled out the BQ25504 as a feasible option, requiring us to come up with an alternate solution.

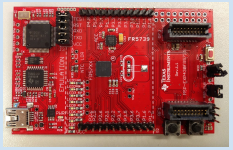


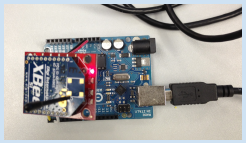


Solution: To resolve this issue, we built our own simple energy harvesting circuitry to store the energy for the MCU. Though this works in the short term, a more suitable energy harvesting system can be realized in a future iteration.

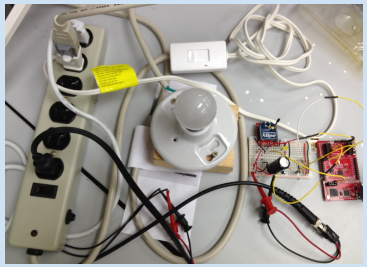
MCU

Complications: Using our current system set-up, the MCU drains the power stored in the capacitor bank almost instantaneously. Our research indicates that in the long term, it is possible to adapt our system to power the MCU; however, with the current configuration, the MCU does not have enough time to store a counter value or send a packet.





Solution: To demonstrate the proof of concept, we are storing the harvested energy in our capacitor bank, then discharging it through an LED when it reaches a known level. This allows us to see the energy collection rate by observing the LED flashes. In addition, the MCU, powered externally, transmits data over UART.



Conclusion: We were able to demonstrate a proof of concept for the parasitic power meter by using harvested energy from a power strip through a transformer. We also demonstrated that we could send packets over radio with an MCU. Though our system was unable to power the MCU for a sufficient amount of time, we believe it is a feasible long term addition through power optimization.