Wireless Building Power Monitor (Hardware Design and Packaging)

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Abstract:

The goal of this project is to develop a wireless sensor device that gathers power quality parameters for a building or residence. It then uploads the data to a cloud computer. Any portable device that has access to the cloud can then monitor the power characteristics of the circuit. Our first testing point will be in the Hopeman Engineering Building in University of Rochester.

My work focuses on hardware design, such as circuit layout, noise control, and packaging design.

Smart Grid:

Combines traditional power hardware with sensing, communication and monitoring technology to:

- Provide a systematic communication between suppliers and consumers.
- Motivate consumers to get involved in Energy management and savings.
- Improve fault detection and allow self-healing of the network.
- Make the grid highly controllable.

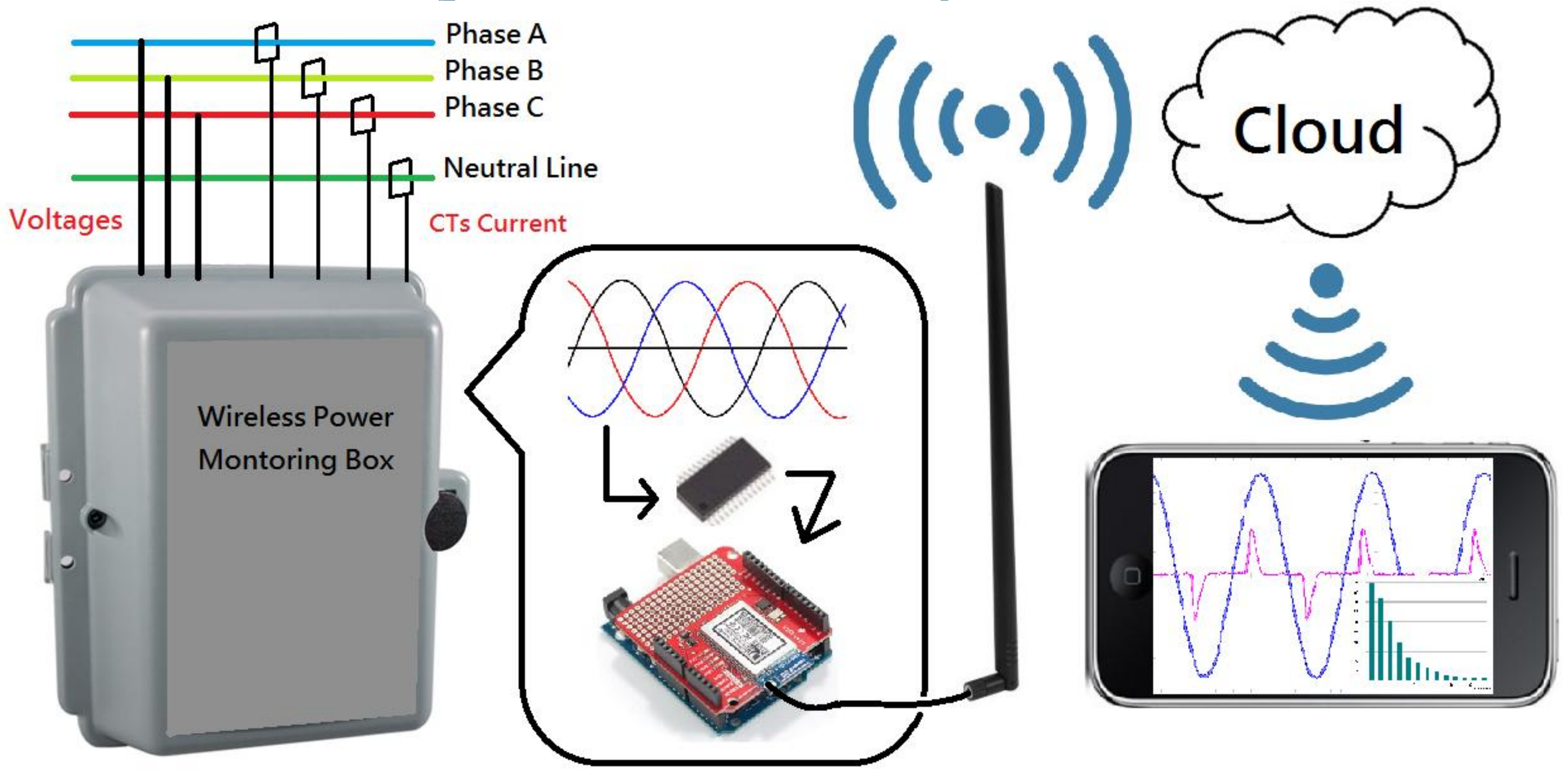
This Wireless Power Monitoring device helps consumers to adopt Demand Side Management (DSM) in order to:

- Encourage the consumer to use less energy during peak hours, or move the time of energy use to off- peak time such as nighttime and weekends.
- Average out the total city power consumption which can reduce the need for investments in networks and power plants

Electrical Power Harmonics:

When a linear electrical load is connected to an AC system, the voltage and current vary sinusoidally at 60Hz. If a non-linear load, such a DC power supply (rectifier), LED light, or motor, is connected to the system, it draws currents containing harmonic components. No matter how complex the current waveform becomes, Fourier Series Analysis can decompose the waveform into a series of simple sinusoids.

System Description:

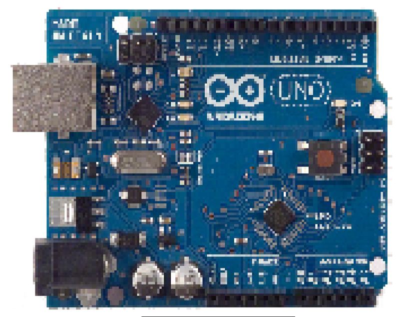


MAXQ3183

Operates at 8MHz

Measure:

- RMS Voltage, Current and Power (Real/ Reactive/ Apparent)
- Fundamental Power
- Phase Angles
- Power Factor
- Line Frequency
- Current/ Voltage Harmonics
- Total Harmonics Distortion



Arduino

- Microcontraller board based on ATmega328
- Operated at 16MHz
- Communicates at 1MHz with 3183
- 14 difital input/output pins
- Able to read/ write the registor in 3183
- One channel shared by both WiFly and 3183

WiFly RN-131C

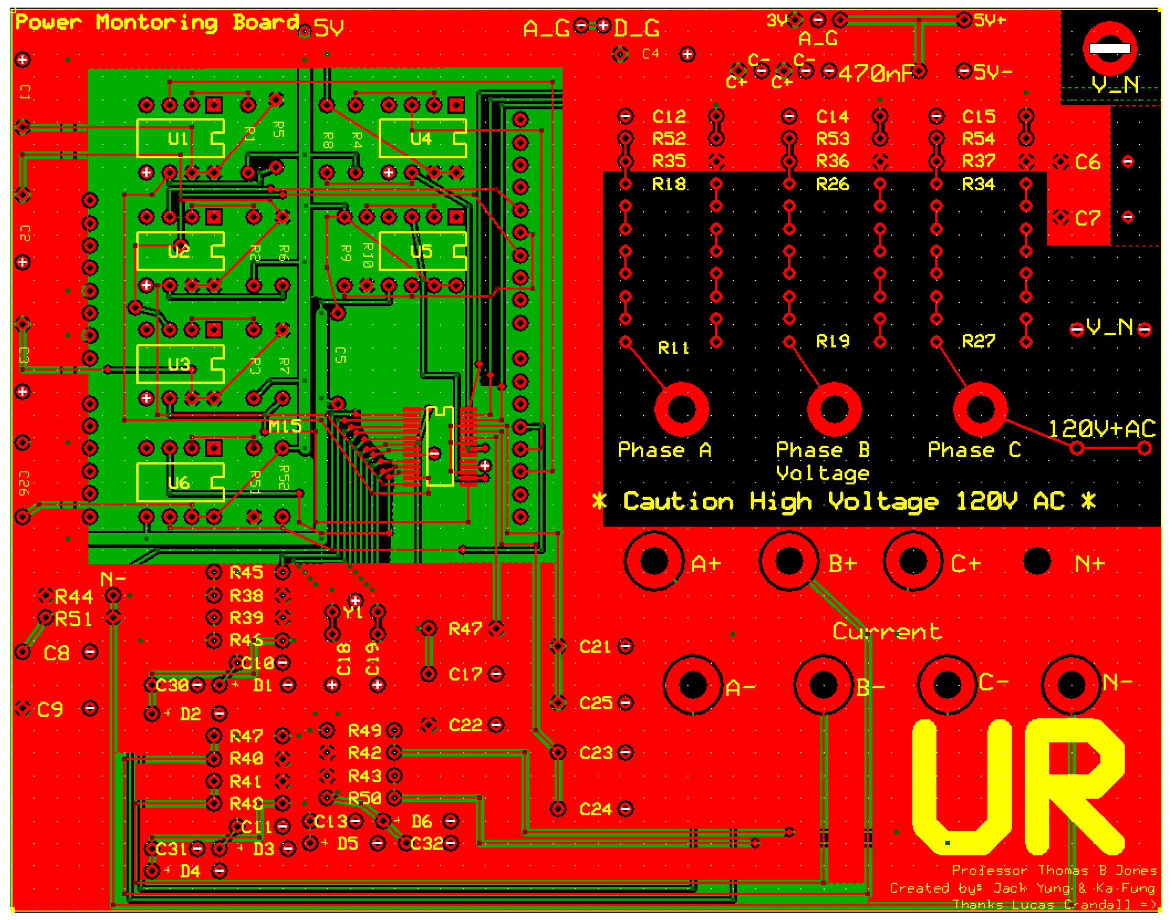
- Ability to connect to 802.11b/g wireless
- Power by Arduino (3.3V)
- Connected to a 2.4 GHz indoor 9 dBi omno-directional antenna
- Transfer data from Arduino to Cloud

The Wireless Power Monitoring device contains three devices, a MAXQ3183 chip, an Arduino board and a WiFly shield. Outside of the box, there is a 9 dBi Omni- directional antenna connected to the WiFly shield.

The power buses that we are testing and monitoring are in Hopeman Building`s basement. A cloud computer is located in the third floor of the same building. We expect our external antenna can transmit the data at least 40 meters radius away from the monitoring box.

Once the cloud computer receive the data, it can either store it, upload it online or transmit it to other drives.

Circuit and PCB Design:



Noise Control:

To reduce the noise, there are copper shields that are connected to either one of: the 3.3V power input, neutral of the current transformer, digital ground and analog ground.

Voltage Measurement:

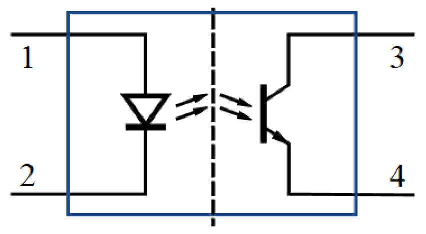
To get low voltages from the power lines to the Maxim chip, we use voltage dividers, calibrating their output voltages in the chip, so that we can get the right ratio between the output of the dividers and the voltages of the three lines.

Current Measurement:

Four 5 Amp to 0.333V current transformers are used to measure the line currents.

Opto-isolator:

Six opto-couplers has been used to isolate the low voltage part of the board from the high voltage part.



Schematic of a Opto-isolator

Acknowledgements

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Reference:
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ARDUINO

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