Arduino-based Wireless Power Monitor

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Purpose

The purpose of this project is to develop a system that monitors and records the power usage and quality of a building. This data is uploaded to a web server and can then be viewed at a later date or in near real time from any web enabled device. This project is a part of the “Smart Grid” program to make the US electric grid more efficient, reliable, and secure.

My work focused on refining the Arduino microcontroller software in order to make the Power Monitor device more user friendly and capable of being deployed for long periods without any hang-ups.

Smart Grid

A combination of sensor technology and two-way communication between consumers and the utility companies will allow for:

- Grid adjustments based on consumer energy demand
- Quicker recovery after electrical faults
- Consumer knowledge of energy usage
- Lower energy costs for utility companies and consumers
- Easier integration of renewable energy sources and consumer owned energy sources

Operation

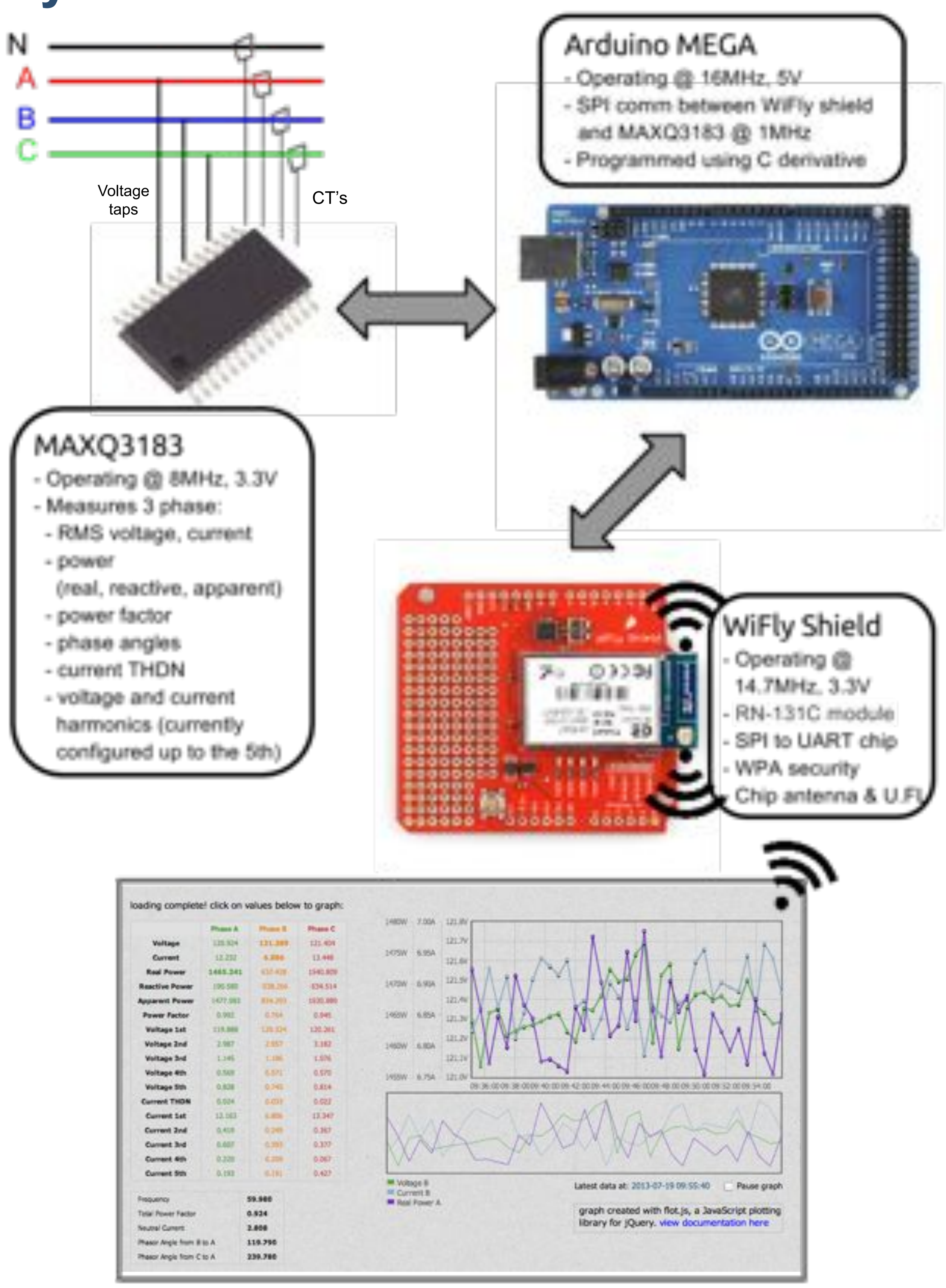
Voltage of each phase is reduced using a resistor network before being inputted to the MAXQ3183. Current through each phase line and the neutral line is measured using current transformers (CT’s). A voltage proportional to the current flowing through each line is generated by the CT’s and connected to the MAXQ3183.

When collecting all parameters up to and including the first five harmonics, the Power Monitor is capable of retrieving new data about every 30 seconds (limitation of MAXQ3183). The web interface has the capability of plotting each measurement to see changes in near-real-time. Users can also download the data as a CSV file for further analysis offline.

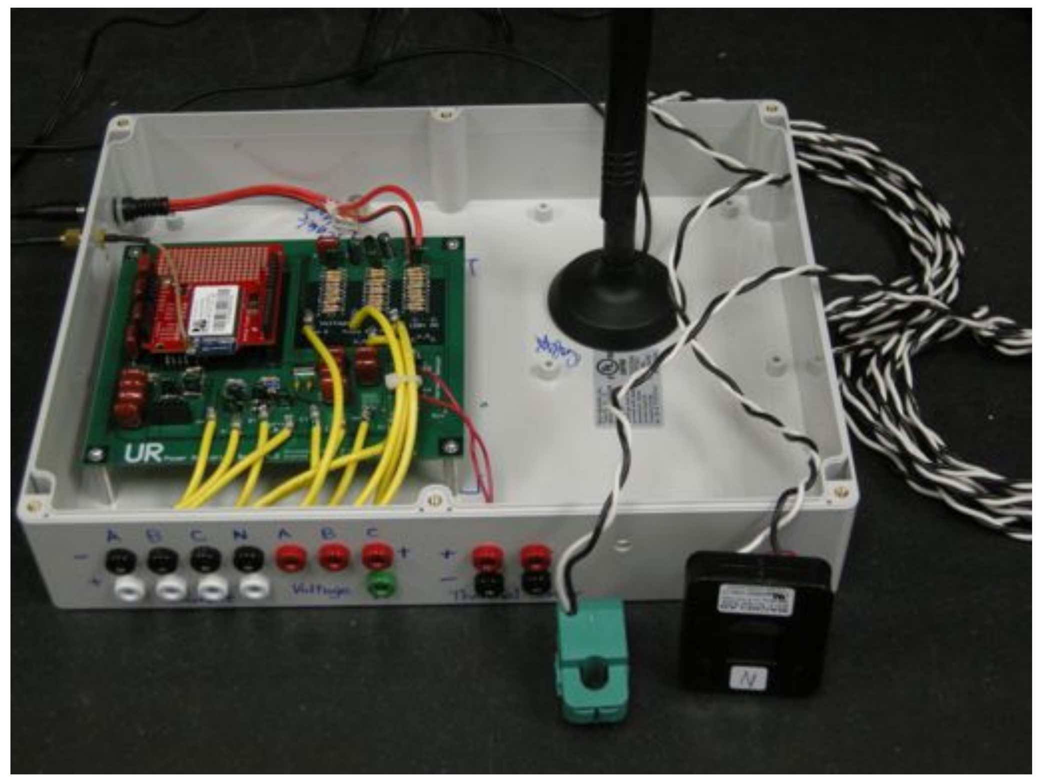
There are currently two monitors deployed: one in the Hopeman Engineering Building and one in the Cogen Plant. Specific CT’s and resistor values provide the necessary scaling, giving the monitor the ability to be configured for a wide range of circuits.

References: *www.sparkfun.com, www.maxim-ic.com, www.smartgrid.gov, www.metersusa.com/Transformers/Data/CTTheory.pdf*

System Overview



Web Interface



Inside the device, showing WiFi antenna and CTs

New Features

Ability for user to select which measurements to be taken

- Javascript and PHP are used to parse the user input from the web and save a command file to the server
- Using a function pointer in the Arduino code; measurement functions are called when the device reads command file from the server

Increased data collection speed

- Maxim chip only has one filter for the harmonic readings which limits the data collection speed
- If harmonics are not requested, data is collected in ~8 seconds

Enhanced operation & security

- Previously: data request from Arduino when a user entered the web interface or scheduled a data collection; IP address frequently changed, the server had to manually be updated
- Now: Arduino continuously sends data to the server
- Improves security because the server does not need the IP address of the device, the device acts as any other client

Remote reset of Arduino

- WiFly shield occasionally gets hung up and cannot connect to the internet
- Watchdog timer built from 555 IC in order to reset the device

Future Plans

Preliminary research has been performed to develop a variation of the device for use in homes. A light-weight version of the Power Monitor could monitor single phase power without using the MAXQ3183, minimizing complexity and cost. All measurements would be gathered using the Arduino’s 10-bit analog to digital converter.

Acknowledgments

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