

# **CONNECT THE MAGIC**

## **2014 DESIGN CHALLENGE**

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*WIZnet*

### **Home Energy Monitor**

## **Project Registration Number: WZ1096**

This project measures real time AC voltage and AC currents of an entire home. Kilowatts (KW) and Kilowatt-hours (KWH) along with the cost of using electricity are then calculated and displayed on the Exosite Portal web site.

The major parts utilized in developing this project include:

- WIZnet WIZ550io Ethernet Module.
- Arduino Uno Board R3.
- AC voltage transformer (VT), two AC current transformers (CT).
- 9vdc Power Supply.

The WIZnet WIZ550io Ethernet Module made it possible to implement such a system that can be accessed and viewed from any PC connected to the internet.

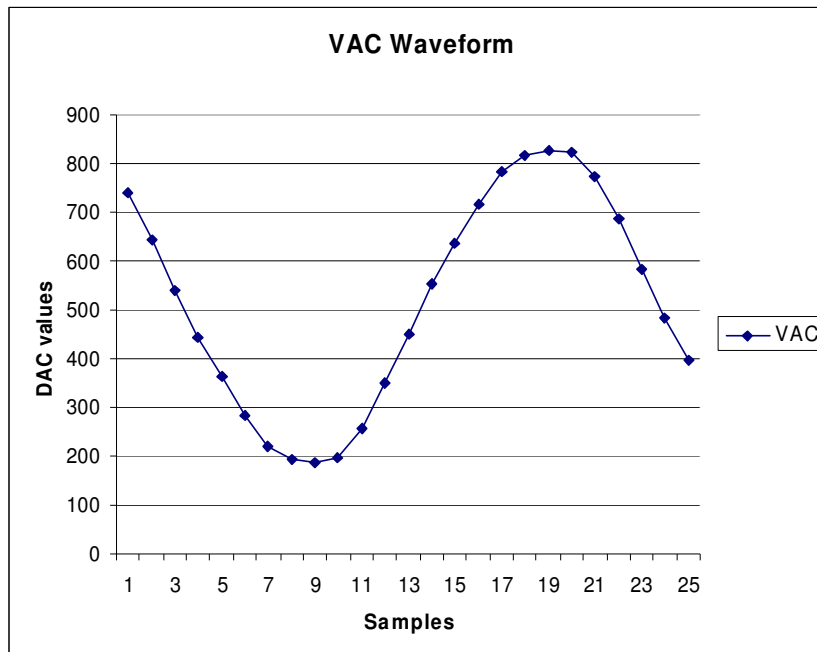
A special feature of this project is that it will take 100 measurements per sampling of the AC voltage and AC currents to obtain accurate readings. To determine if the analog input was in fact measuring the waveform accurately, another routine was used to send the readings to a PC serially and then using Microsoft Excel to plot the values. See the code listing on the next page for the waveform measurement. This was used during the debug phase.

```

//=====
void Waveform_VAC()
//=====
{ // Get 25 AC voltage samples.
  if (VAC_present)
  {
    for (LP1=0; LP1<25; LP1++)          // Loop 25 times
    {
      delayMicroseconds(700);           // delay between
                                          sampling.
      VACreading = analogRead(sensorPinA0); // Read AC voltage.
      VA_READING[LP1]=VACreading;        // LP1 -> 0-24.
    }
  }
//=====
// Send AC Voltage values to trend on PC via serial port.
//-----
  for (LP1=0; LP1<25; LP1++)          // Loop 25 times.
  {
    Serial.println(VA_READING[LP1]);   // Send data to PC.
  }
}

```

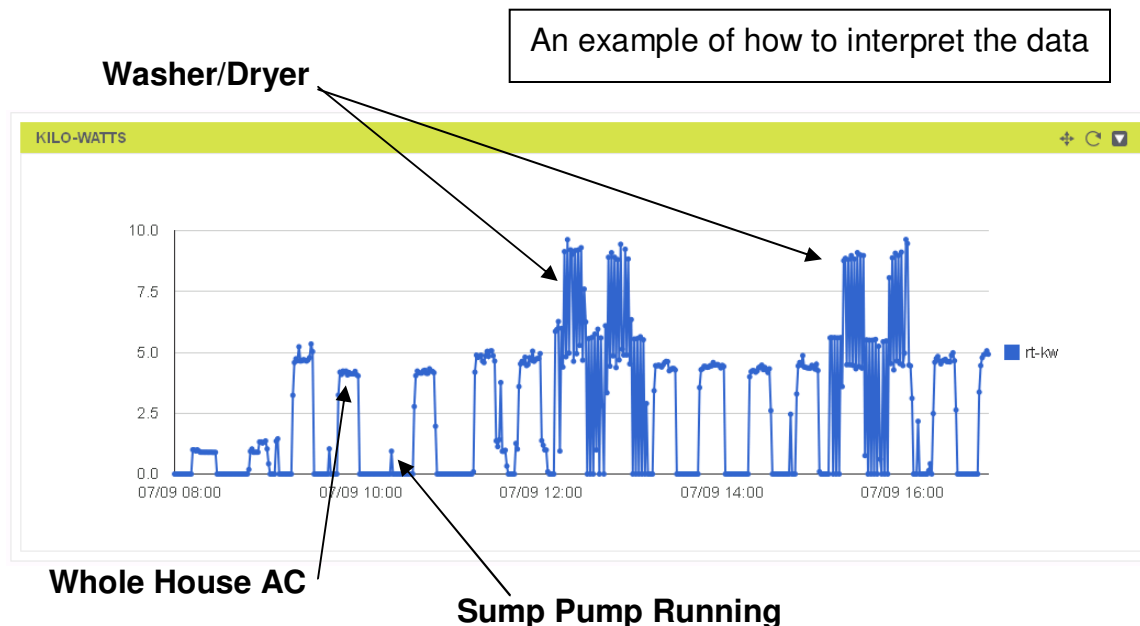
The resulting plot shows that the waveform is being measured correctly and accurately. You can see from the data points collected that a uniform measurement is being taken throughout the waveform. The AC voltage waveform routine is only taking 25 measurements to get a sense for how accurately the waveform is actually being measured.



As for the AC voltage measurement routine, 100 measurements are taken to accurately determine the AC voltage. The real-time AC voltage and AC currents are measured every two seconds. These are used to construct one minute average readings for calculating hourly KWH and the cost associated with the power usage. The following information is displayed on the Exosite Portal web site for viewing any time of the day or night!

- One minute update of real-time readings. (AC voltage, AC current, and calculated KWs)
- Hourly and Daily KWHs and Costs.
- Cost per KWH can be entered from your electric bill to check if the power company is accurately measuring your POWER USAGE!

It's very interesting to visualize how appliances operate and can detect if one needs to be replaced or not working properly. This is a great project to learn more about your power usage in the home and what appliances or people in your household use the most electricity.

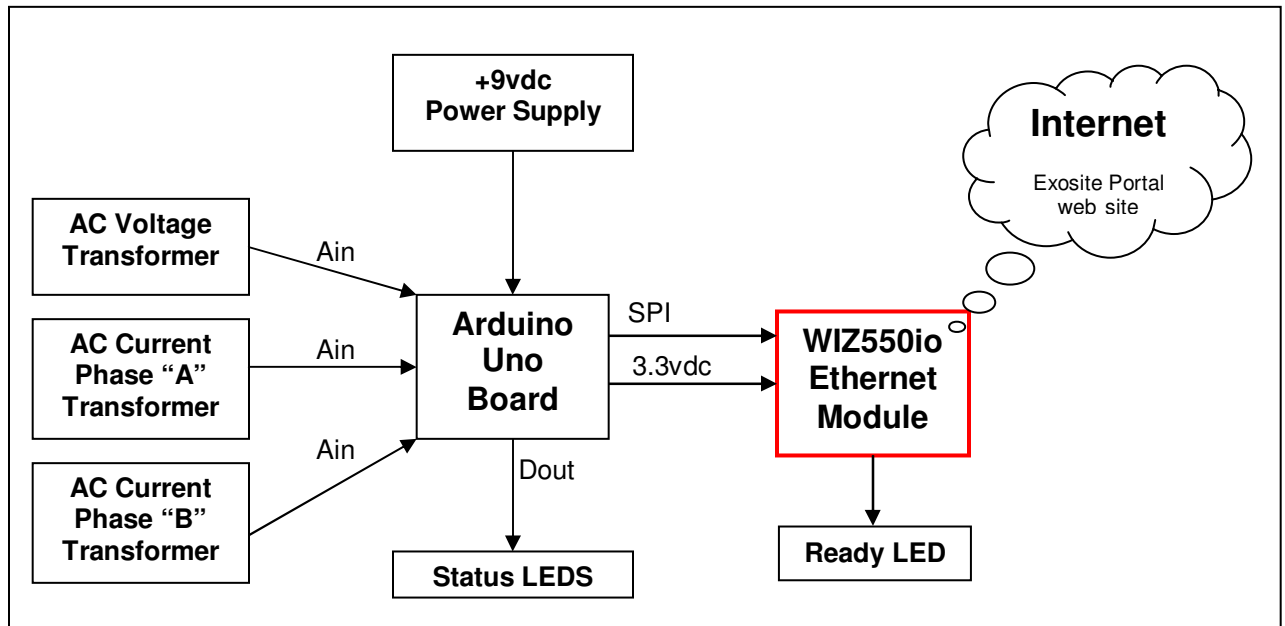


From the chart one can observe the whole house air conditioning cycling throughout the day (this is similar with heating but larger KWs are measured). When the washer/dryer is running it is apparent from the cycling of the KWs in a short period of time (this is similar with the dishwasher as well but with smaller

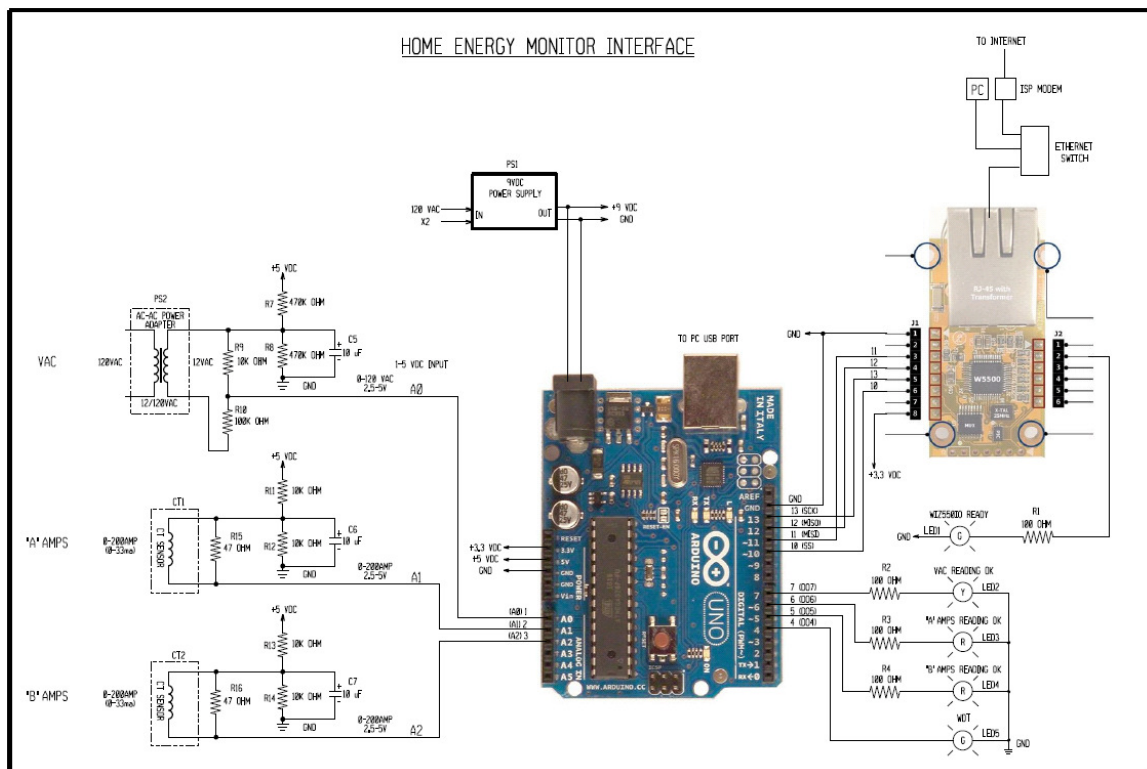
KWs measured). Also the small spikes indicated that the sump pump was running.

The following is a block diagram showing the connections between the project's main components.

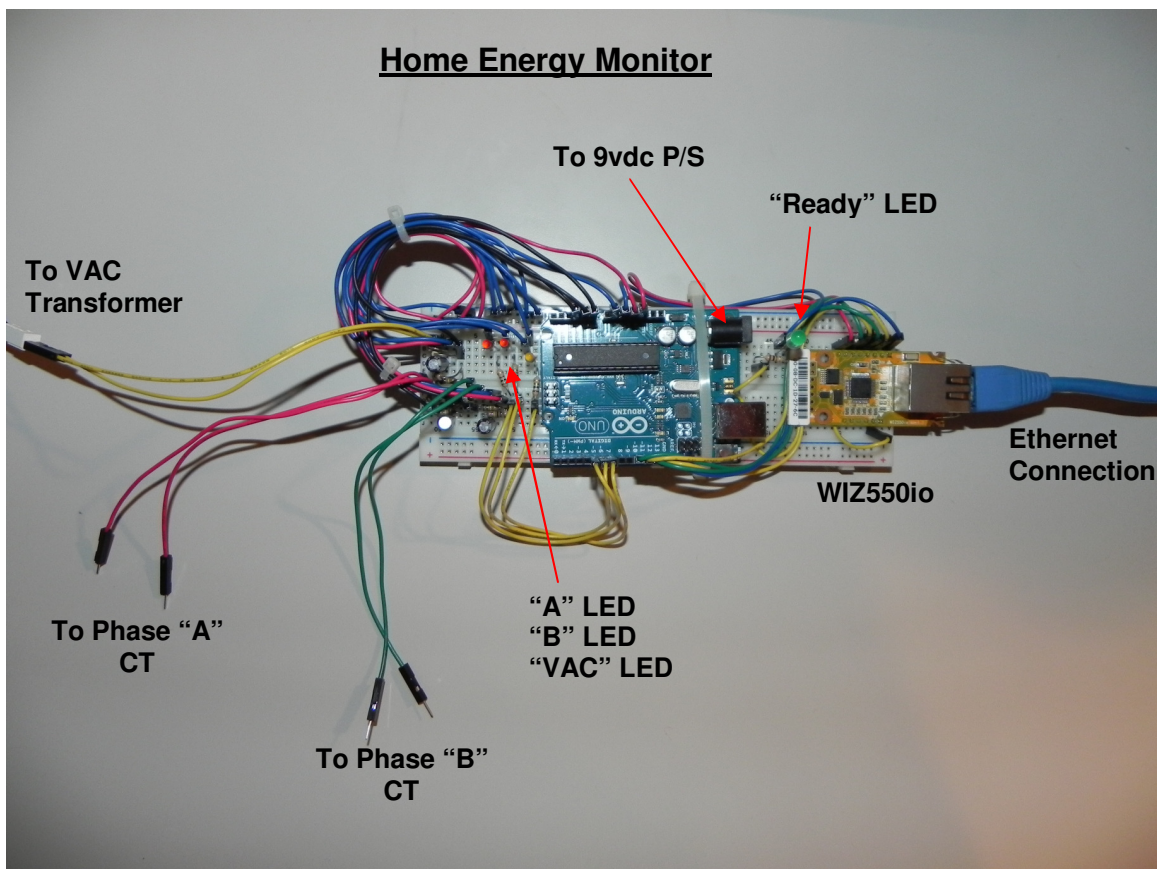
### **Block Diagram:**



The completed schematic is shown below:



The following is a photo showing the completed board. The WIZ550io ethernet module is wired to a Arduino UNO board using a bread board and jumper wires. This board will be placed inside the main AC voltage load center where phase “A” and “B” CTs and a VT can be connected. A ethernet cable will be run to the load center to connect the WIZ550io ethernet module to the Exosite Portal web site for data viewing and logging. LEDs connected to the Arduino UNO board will turn “on” indicating a good connection/status of the transformers. The LED connected to the WIZ550io ethernet module will turn “on” when the module is ready and operational.





The completed project installed inside the Main AC Voltage Load Center:

- Note the cover can be safely re-attached to the load center.

