ECE 3334 Group 4
Interim Presentation

PowerPlus

Kenneth Cody

Computer Engineer

Justin Price

Computer Engineer

Juan Torres

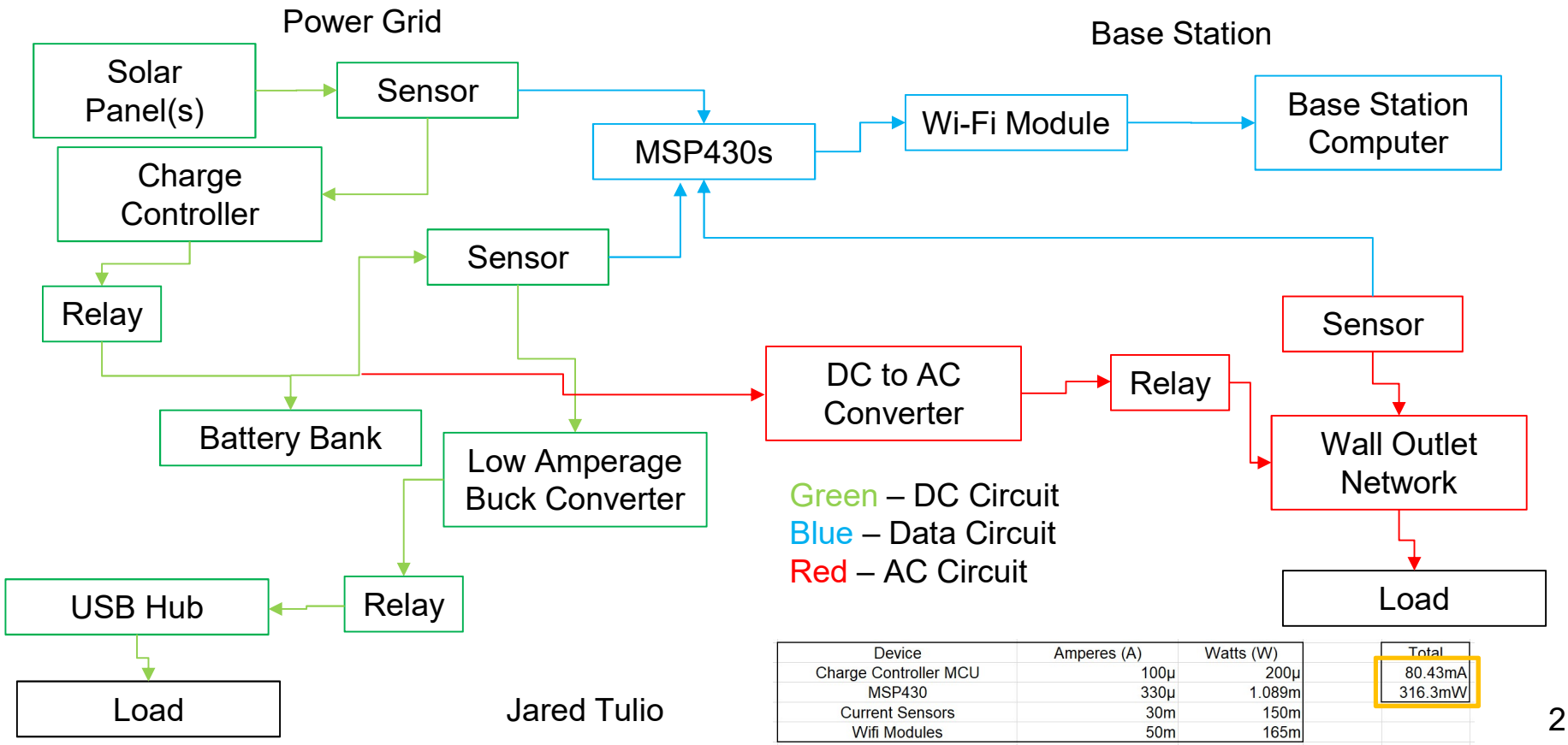
Electrical Engineer

Jared Tulio

Electrical Engineer – Team Lead

March 8, 2018

Hardware Flowchart



Device	Amperes (A)	Watts (W)	Total
Charge Controller MCU	100µ	200µ	80.43mA
MSP430	330µ	1.089m	316.3mW
Current Sensors	30m	150m	
Wifi Modules	50m	165m	

Jared Tulio

System Description

- This project utilizes a solar panel in order to power a microgrid containing both DC and AC power components.
- The system is monitored using sensors communicating with MSP430G microcontrollers.
- The data collected by the sensors is transmitted to a base station PC using XBee Wi-Fi modules to be displayed to the user via a GUI.

Safety

- Make sure to have a high voltage sign when working with high voltage.
- Lead-Acid Batteries are made up of sulfuric acid and water solution. Lead-acid batteries also produce Hydrogen gas when charged. Careful for hydrogen is flammable in nature.
- Sulfuric Acid has a PH lower then two. Therefore it is corrosive material and will burn your eyes and skin.
- Never open battery caps with your face over the battery.
- Even disconnected batteries can be dangerous for some are capable of discharging extremely high rates of current.
- Make sure to remove jewelry before working near batteries.
- There is a emergency stop button in the lab do not forget to use it if you need to.
- Emergency Stop Button on hardware and software

Division of Labor

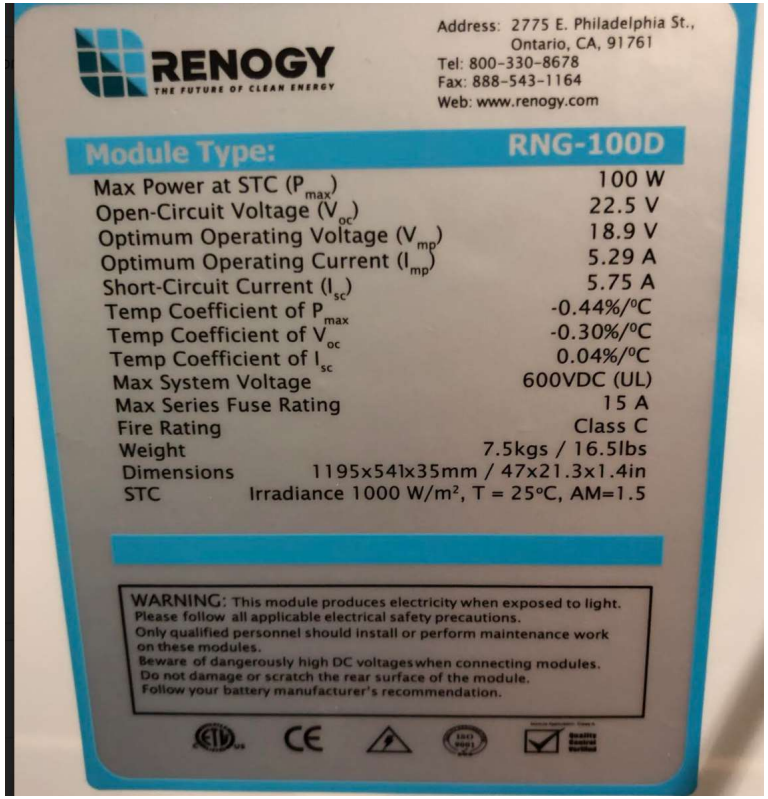
Base Station Software and UI: Kenneth

Microgrid Sensors and Communication: Justin

Battery and Power: Juan

Power Conversion and Grid Construction: Jared

Renogy 100W Solar Panel



[1]

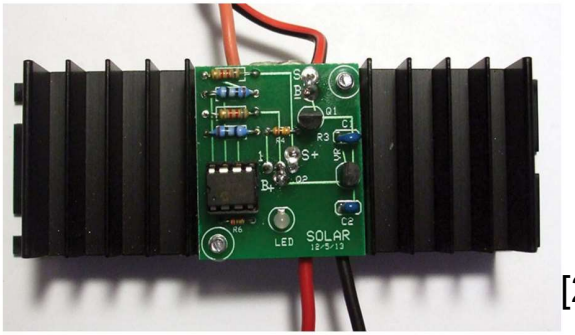
Charge Controller Microcontroller

MICROCHIP

PIC12F675-I/P

[11]

- Standby Current:
  - 1 nA @ 2.0V, typical
- Operating Current:
  - 8.5 μA @ 32 kHz, 2.0V, typical
  - 100 μA @ 1 MHz, 2.0V, typical



[2]

Relay

G5LE
PCB Power Relay

Cubic, Single-pole 10A Power Relay

Relay Type	General Purpose
Coil Type	Non Latching
Coil Current	16.7mA
Coil Voltage	24VDC
Contact Form	SPST-NO (1 Form A)
Contact Rating (Current)	10A
Switching Voltage	250VAC, 125VDC - Max
Turn On Voltage (Max)	18 VDC
Turn Off Voltage (Min)	2.4 VDC
Operate Time	10ms
Release Time	5ms
Features	Insulation - Class B, Sealed - Fully
Mounting Type	Through Hole
Termination Style	PC Pin
Operating Temperature	-40°C ~ 85°C
Contact Material	Silver Tin Oxide (AgSnO)
Coil Power	400 mW
Coil Resistance	1.44 kOhms

[3]

Battery

ExpertPower EXP12200 12 Volt 20 Ah Rechargeable Battery With Threaded Terminals

12.13 lbs
5.50 kg

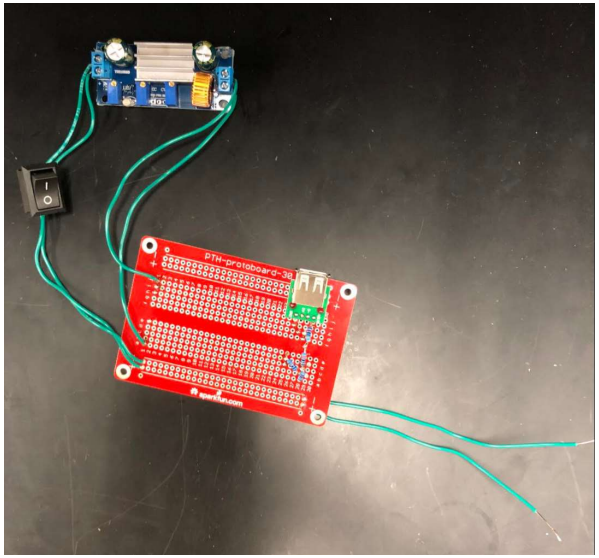
12 Volt
1200 Watt

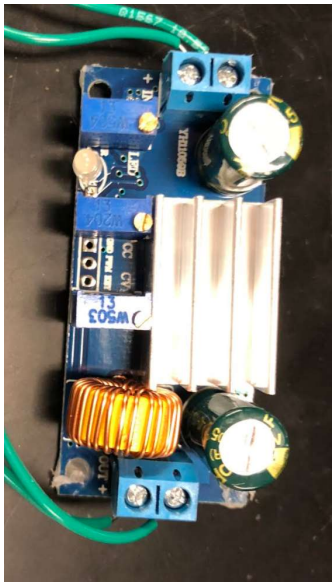
20 AH
20 HR

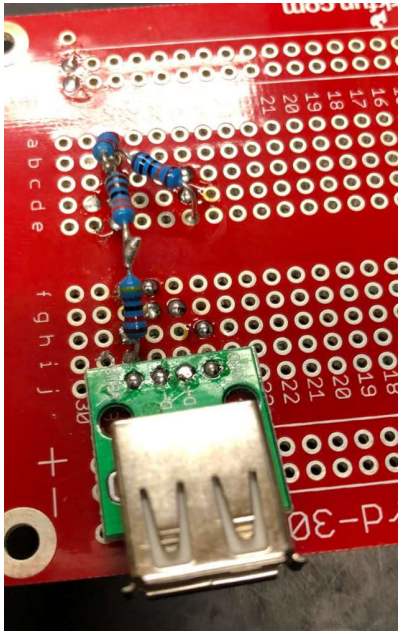
B1 Type
Terminal

[4]

USB Charging Circuit







Video

DC to AC Inverter

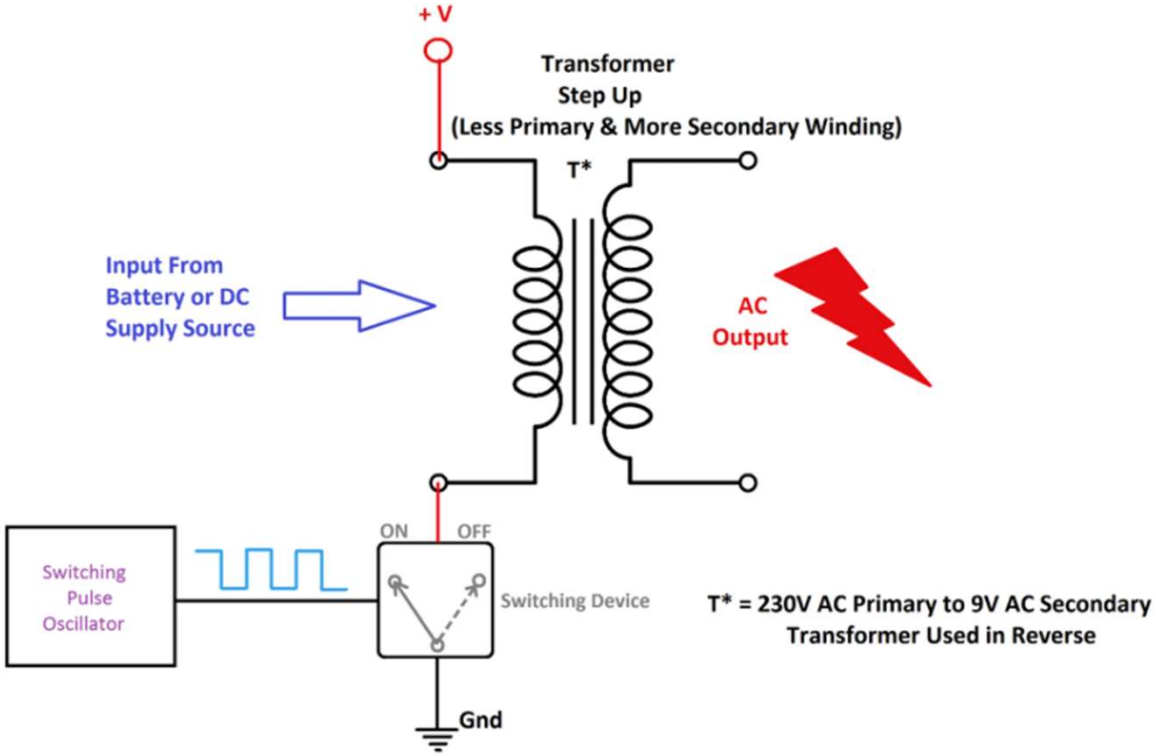


Figure 2: How a switching inverter works[5]

DC to AC Inverter

- Inverter circuits are useful for portable power sources. When the load connected to the inverter circuit is very small there is no need for a perfect sine wave. Instead a much more simple inverter circuit can be utilized to power low power devices.
- The circuit I created is made up of three parts: a 60Hz Oscillator, two power mosfet transistors to amplify the signal and a transformer.
- The transformer is 120V primary to 12V secondary connected in reverse, so that it can react as a step up transformer.
- By applying a +12v DC bias to this circuit a 120V AC output is acquired with 60Hz frequency however output is a pulsated AC

Convert DC to AC

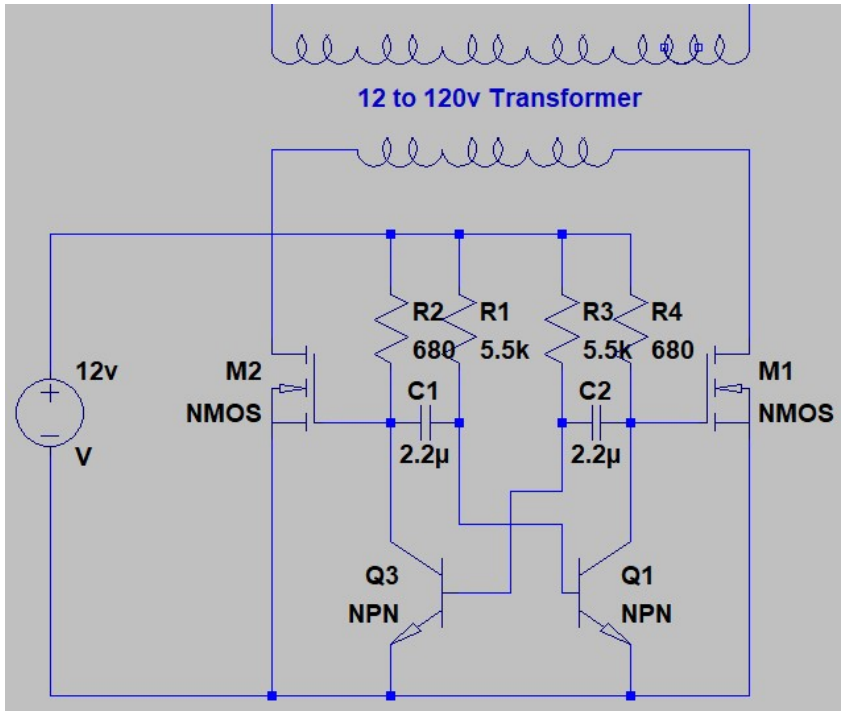


Figure 9: DC to AC Inverter Schematic

Convert DC to AC

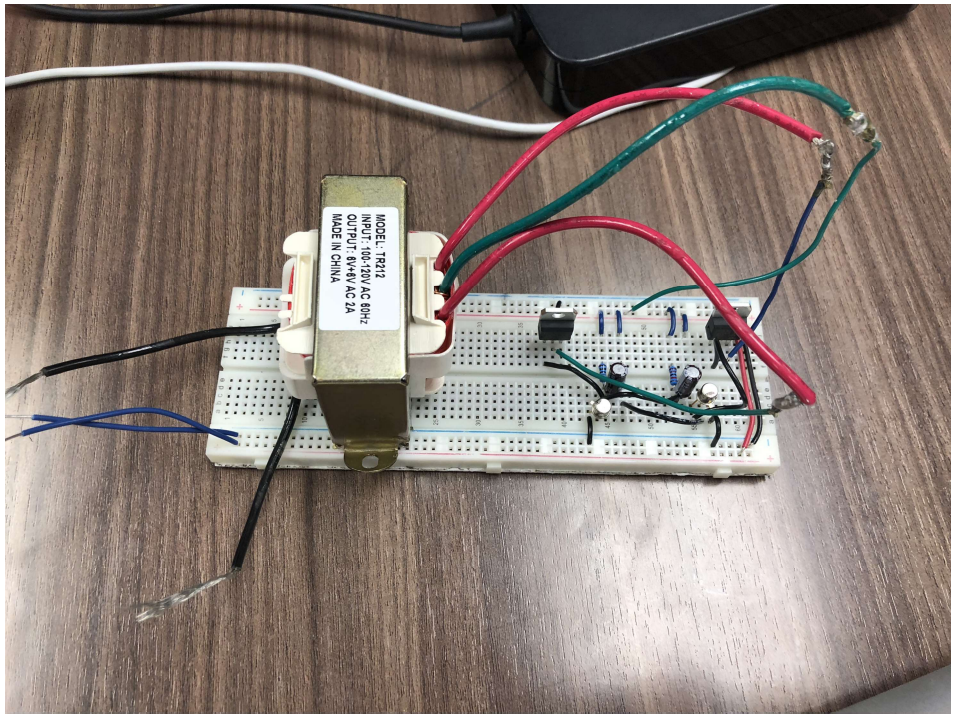


Figure 10: DC to AC Inverter

DC to AC Inverter

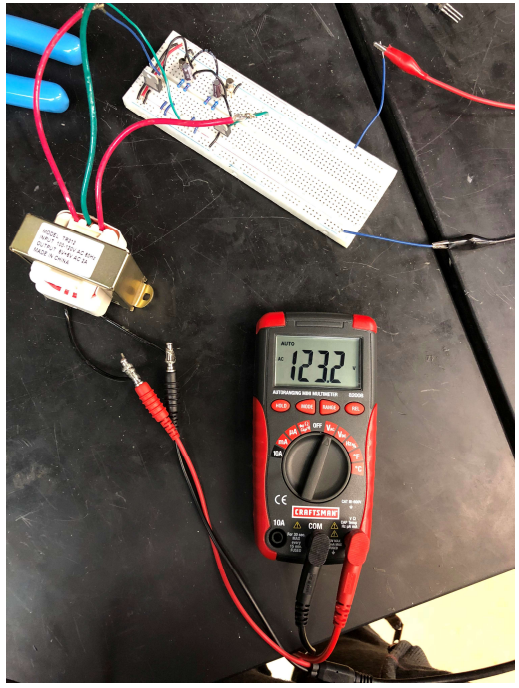


Figure 11: Multimeter of AC Voltage

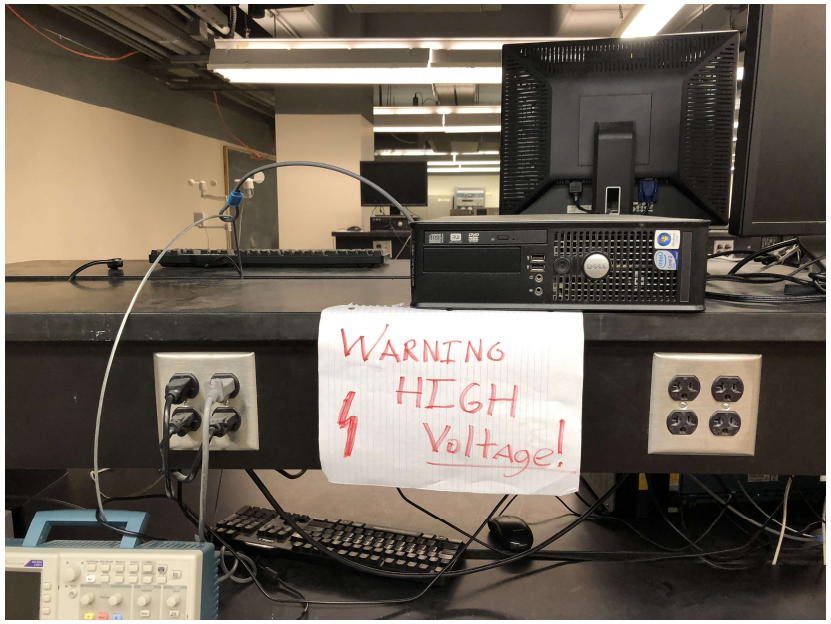


Figure 12: High Voltage Warning Sign

Video Of DC to AC Inverter

L07P010S05 Current Sensor

Parameters	Symbol	L07P003S05	L07P005S05	L07P010S05	L07P015S05	L07P020S05	L07P025S05	L07P030S05
Primary nominal current	I_f	3A	5A	10A	15A	20A	25A	30A
Saturation current	I_{fmax}	≥ ± I_f x 1.5						
Rated output voltage	V_o	V_{of} + 1.250V ± 0.040V (at If)						
Offset Voltage[1]	V_{of}	Vref [1] ± 0.040V (at If = 0A)						
Output Linearity[2](0A~If)	ε_L	≤ ±1% (at If)						
Power supply voltage	V_{CC}	+ 5V ± 5%						

- Using the 5A module (green square)
- 2.5V at 0A input current [6]
- Output voltage range from 0 to 3.5V with input current from 0 to 5A
- Will take measurements through a voltage divider

Timer A0 interrupt Code

```
#pragma vector=TIMER0_A0_VECTOR
__interrupt void badprog_timer_a0(void) {
  TACCTL0 = 0; //Disable further interrupts
  if(Channel == 0){ Channel = 6;}
  Channel = Channel - 1; // Decrement the channel
  ADC10CTL0 &= ~ENC;  // Stop conversion so the control register can be changed (pg 555 of MSP430 family guide)
  ADC10CTL1 = 0; //Might need if channel still does not change !!!!
  switch(Channel){
  case 0 : { ADC10CTL1 |= INCH_0; break;} //Not needed but included for easy way to see which channels are used
  case 2:  { ADC10CTL1 |= INCH_0; Channel = 0; break;} //If on 2, go straight to channel 0 and update Channel variable accordingly
  case 3 : { ADC10CTL1 |= INCH_3; break;} //Set which channel to read on
  case 4 : { ADC10CTL1 |= INCH_4; break;}
  case 5 : { ADC10CTL1 |= INCH_5; break;}
  }
   ADC10CTL0 |= ADC10ON; //Turn on ADC
   ADC10CTL0 |= (ENC | ADC10SC); // Start conversion

  }
```

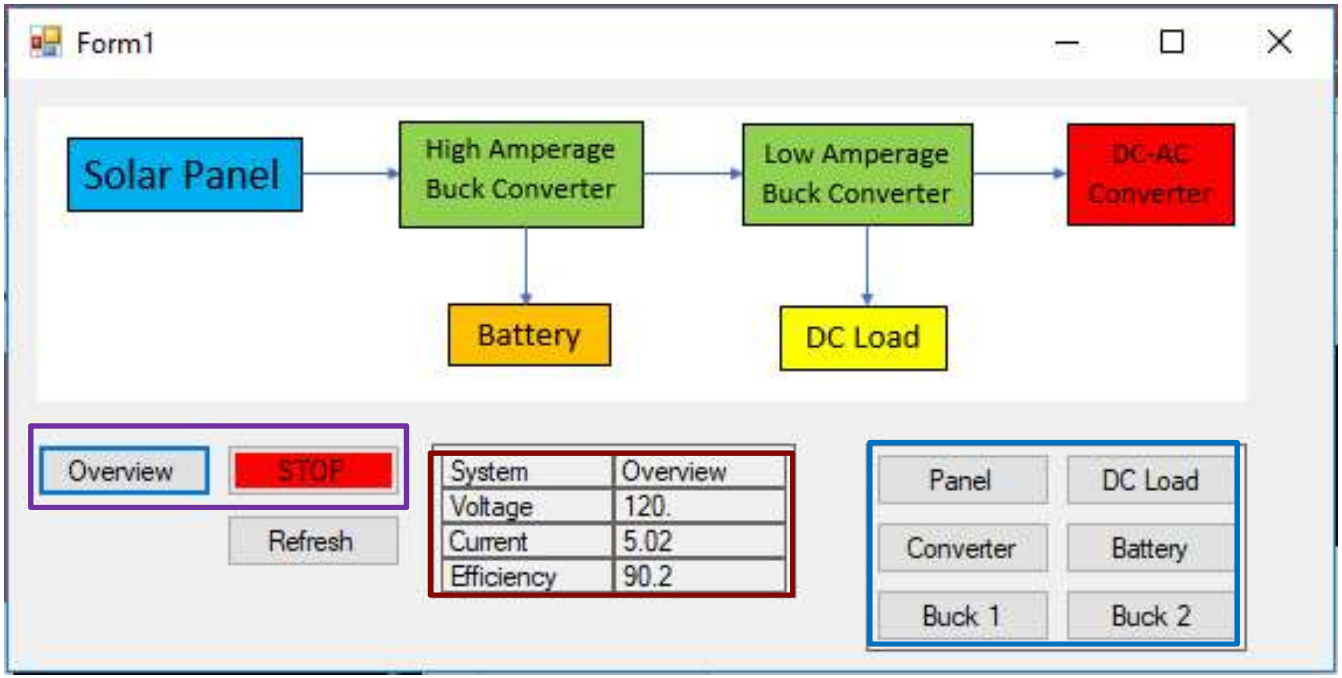
- Change which channel we are reading every time the timer turns off
- Need to turn ENC bit low in order to change any control registers (Black square)

ADC Test Video

Xbee module plans

- Use a USB to TTL converter to communicate the module to the Base Station
- Communicate with the MSP430 over UART (8-N-1) 9600 baud rate
- Will configure the modules network address, channel, and destination address to non-default values
- Range testing to see if the module communicates over the distance we need

GUI


Form1
Solar Panel
High Amperage Buck Converter
Low Amperage Buck Converter
DC-AC Converter
Battery
DC Load
Overview
STOP
Refresh
System
Overview
Voltage
120.
Current
5.02
Efficiency
90.2
Panel
DC Load
Converter
Battery
Buck 1
Buck 2

GUI Video

GUI Code Sample

```
private void button1_Click(object sender, EventArgs e)
{
    serialPort1.Open();
    serialPort1.WriteLine("1");
    string data = serialPort1.ReadLine();

    this.label1.Text = "System";
    this.label2.Text = "Voltage";
    this.label3.Text = "Current";
    this.label4.Text = "Efficiency";

    this.label5.Text = "Panel";
    this.label6.Text = data.Substring(0, 4);
    this.label7.Text = data.Substring(4, 4);
    this.label8.Text = data.Substring(8, 4);
    serialPort1.Close();

}
```

```
incommingByte=Serial.read();
if(incommingByte=='1')
 {
  Serial.println("12.42.3385.0");
          // wait for a second
    digitalWrite(LED, LOW);    // turn the LED off by making the voltage LOW
    delay(500);
    digitalWrite(LED, HIGH);
 }
```

GUI Development Plans

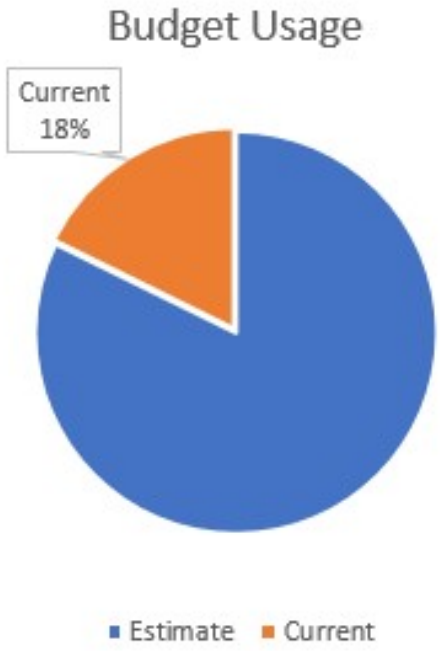
- Switch to TTL to USB cable
- Improve GUI System Diagram
- Swap MSP430G2553LP for XBee Wi-Fi module

Total Budget

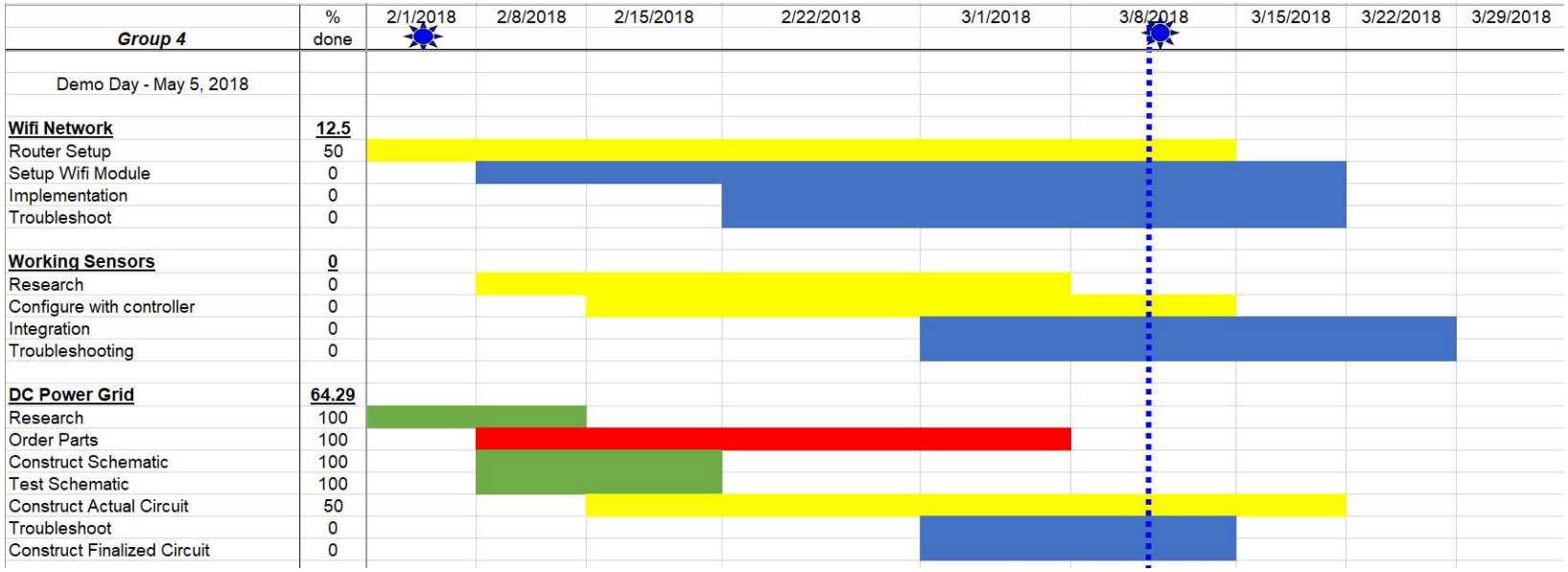
Lab 3 - Group 4	Running Total			Total Estimate			Start Date	2/1/2018
Direct Labor:							**Today**	3/8/2018
Category or individual:	*Rate/Hr*	*Hrs*		*Rate/Hr*	*Hrs*			
Kenneth	18	55	$990.00	18	215	$3,870.00	**End Date**	5/5/2018
Jared	18	50	$900.00	18	215	$3,870.00	**Days Past**	35
Justin	18	53	$954.00	18	215	$3,870.00	**Total Days**	93
Juan	18	48	$864.00	18	215	$3,870.00	**Days Left**	58
DL Subtotal (DL)		Subtotal:	$3,708.00		Subtotal:	$15,480.00		
Labor Overhead	*rate:*	100%	$3,708.00	*rate:*	100%	$15,480.00		
Total Direct Labor (TDL)			$7,416.00			$30,960.00		
Contract Labor:								
Lab 1 Help	$15	0	$0.00	$15	0	$0.00		
Lab 2 Help	$18	0	$0.00	$18	0	$0.00		
Lab 3 Help	$18	0	$0.00	$18	10	$180.00		
Lab 4 Help	$18	0	$0.00	$18	15	$270.00		
Lab 5 Help	$25	0	$0.00	$25	10	$250.00		
Tutors	$40	0	$0.00	$40	15	$600.00		
Lab Assistants	$40	0	$0.00	$40	15	$600.00		
Woodcock	$100	0	$0.00	$100	5	$500.00		
Prof. Ray	$200	2	$400.00	$200	20	$4,000.00		
Total Contract Labor (TCL)			$400.00			$6,400.00		
Direct Material Costs:			$120.00			$650.00		
(from Material Cost worksheet)								
Total Direct Material Costs: (TDM)			$120.00			$650.00		
Equipment Rental Costs:	Value	Rental Rate		Value	Rental Rate		Date begin	Date end (or today)
Oscilloscope	$5,300.00	0.20%	$371.00	$5,300.00	0.20%	$985.80	2/1/2018	5/5/2018
Function Generator	$500.00	0.20%	$35.00	$500.00	0.20%	$93.00	2/1/2018	5/5/2018
DMM	$958.00	0.20%	$67.06	$958.00	0.20%	$178.19	2/1/2018	5/5/2018
Power Supply	$1,700.00	0.20%	$119.00	$1,700.00	0.20%	$316.20	2/1/2018	5/5/2018
Soldering Station	$100	0.20%	$7.00	$100.00	0.20%	$18.60	2/1/2018	5/5/2018
Total Rental Costs: (TRM)			$592.06			$1,573.19		
Total TDL+TCL+TDM+TRM			$8,528.06			$39,583.19		
Business overhead		100%	$8,528.06		100%	$39,583.19		
Total Cost:		**Current**	$17,056.12		**Estimate**	$79,166.38		

Jared Tulio

Gantt Chart



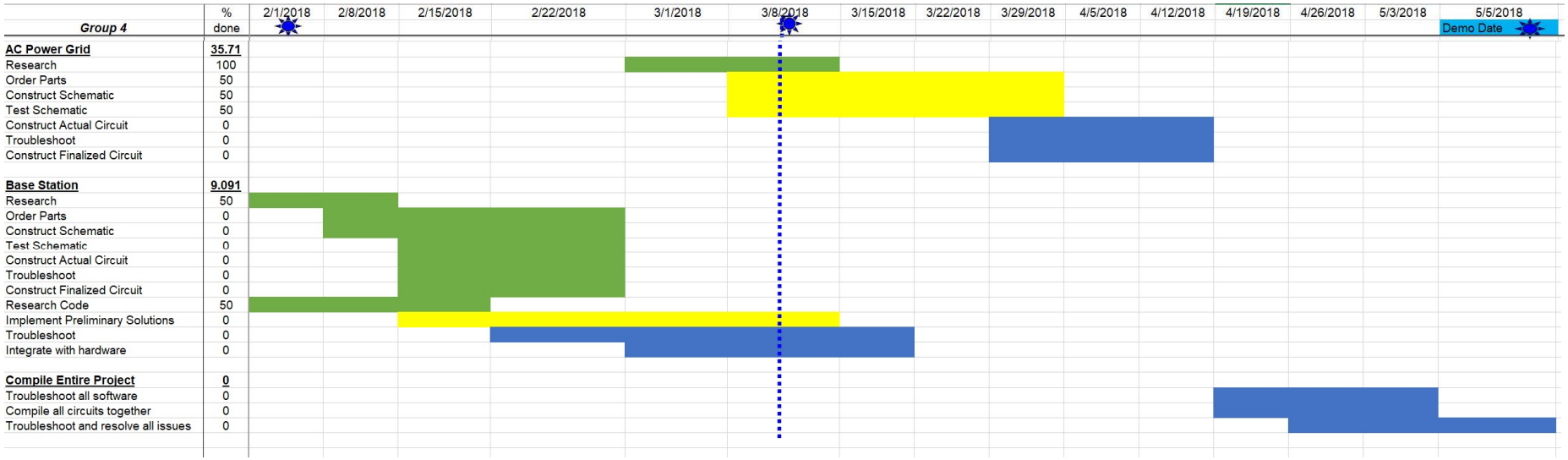
Gantt Chart



Key	
Completed	
In Progess	
Haven't Started Yet	
Completed, with delays	

Milestones	Date
Wife Network	3/15/2018
Working Sensors	3/22/2018
DC Power	3/15/2018
AC Power	4/12/2018
Base Station	3/22/2018
Combining Everything	5/3/2018

Gantt Chart Cont'd



Key	
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Completed, with delays	

Milestones	Date
Wife Network	3/15/2018
Working Sensors	3/22/2018
DC Power	3/15/2018
AC Power	4/12/2018
Base Station	3/22/2018
Combining Everything	5/3/2018

Future Task Division

Kenneth Cody

- Complete GUI Development
- Move to assisting Justin with XBee Module Communication

Jared Tulio

- Completing DC power construction
- Move to Grid Construction

Juan Torres

- Complete DCAC converter
- Move to Grid Construction

Justin Price

- XBee module communications
- Implement Sensors

References

[1] https://www.renogy.com/renogy-100-watt-12-volt-monocrystalline-solar-panel/#tab_prd-specs

[2] https://www.digikey.com/product-detail/en/omron-electronics-inc-emc-div/G5LE-1A4-DC24/Z2254-ND/369017

[3]https://www.amazon.com/gp/product/B00KC39BE6/ref=oh_aui_detailpage_o01_s01?ie=UTF8&th=1

[4] http://www.nutsvolts.com/index.php?/magazine/article/March2014_Newton

[5] http://www.theorycircuit.com/simple-inverter-circuit-using-ic-555/

[6]http://www.mouser.com/ds/2/397/L07PXXXS05-467715.pdf

Questions?