Oil Well Monitoring System

Presented By:-

Louis Bengtson

Kaleb Stunkard

Jimit Shah

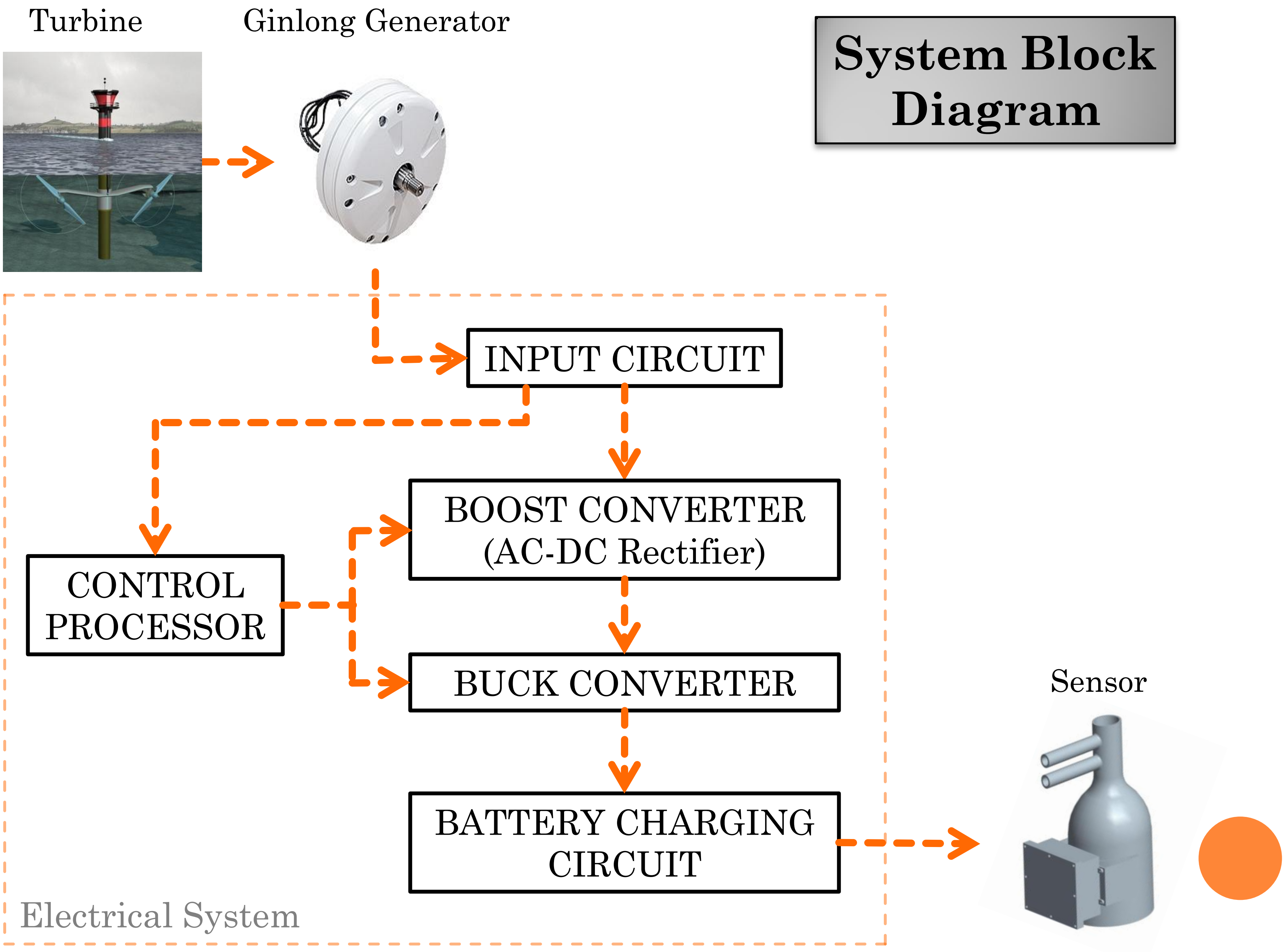
HARRIS

Motivation

- More than 27,000 oil wells permanently abandoned in the Gulf of Mexico.
- Currently, there is no monitoring system available.

- Four teams:
  1. Buoy Team (Mechanical Engineering)
  2. Bi-directional Turbine Team (Mechanical Engineering)
  3. Sensor Team (Mechanical Engineering)
  4. Electrical Team (Electrical Engineering)

System Block Diagram



Goals & Objectives

- Efficiently convert varying AC voltage to steady DC voltage.
- Be able to charge a battery that will supply the necessary output voltage to the sensors.
- Must be self powered.
- Must perform PFC on the AC signal.
- Must be able to work in high and low pressure environment.
- Must be suitable for dry and wet conditions.

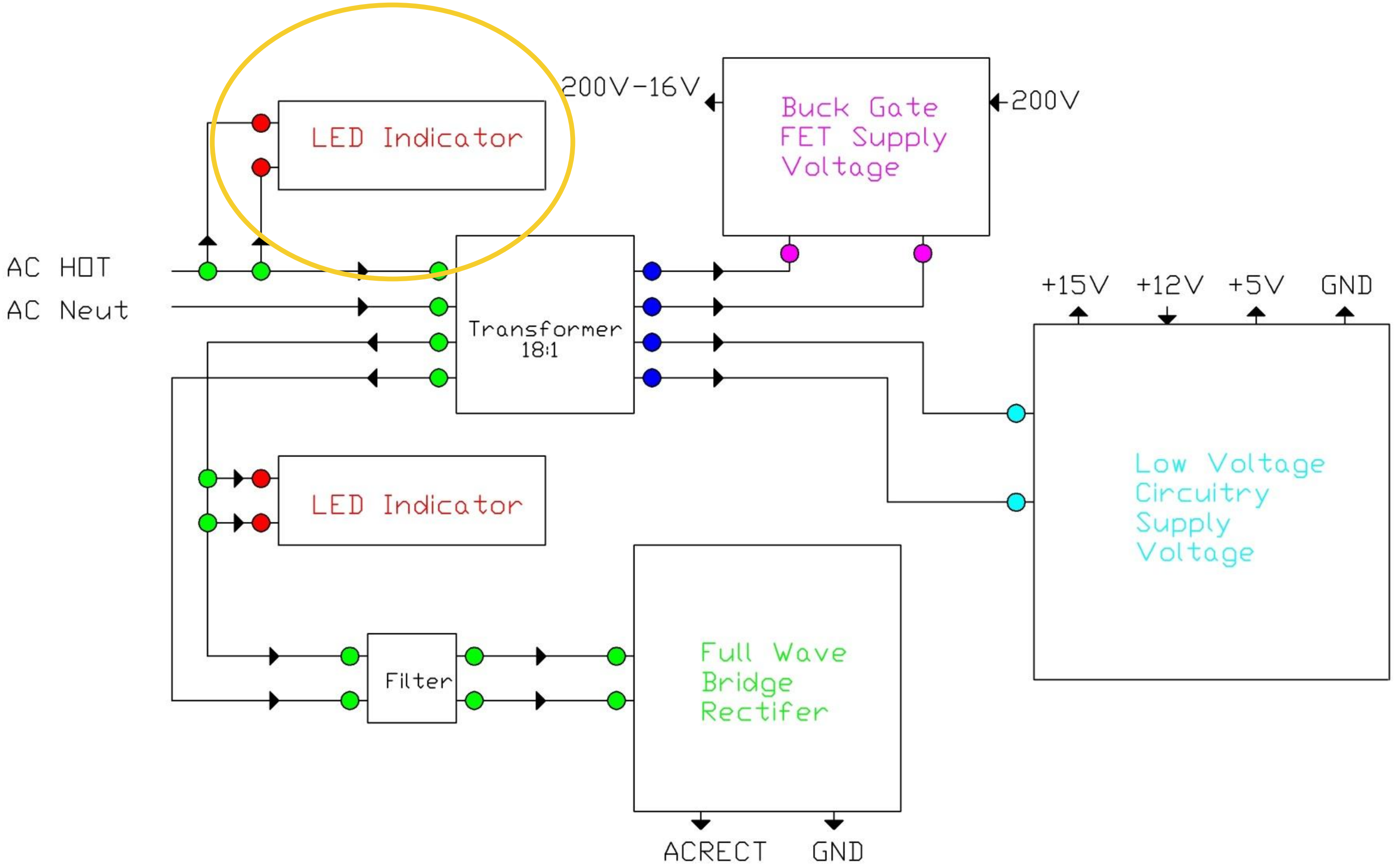
Specifications

- Input RPM range: 90 to 125 RPM
- Input Voltage range: 20VAC to 30VAC
- Output Current: 3A
- Output Voltage: 12VDC
- Cost: Less than $2,000
- Efficiency: 85%
- Operating Environments
  - Temperature: 25 to 110°F
  - Humidity: 100%

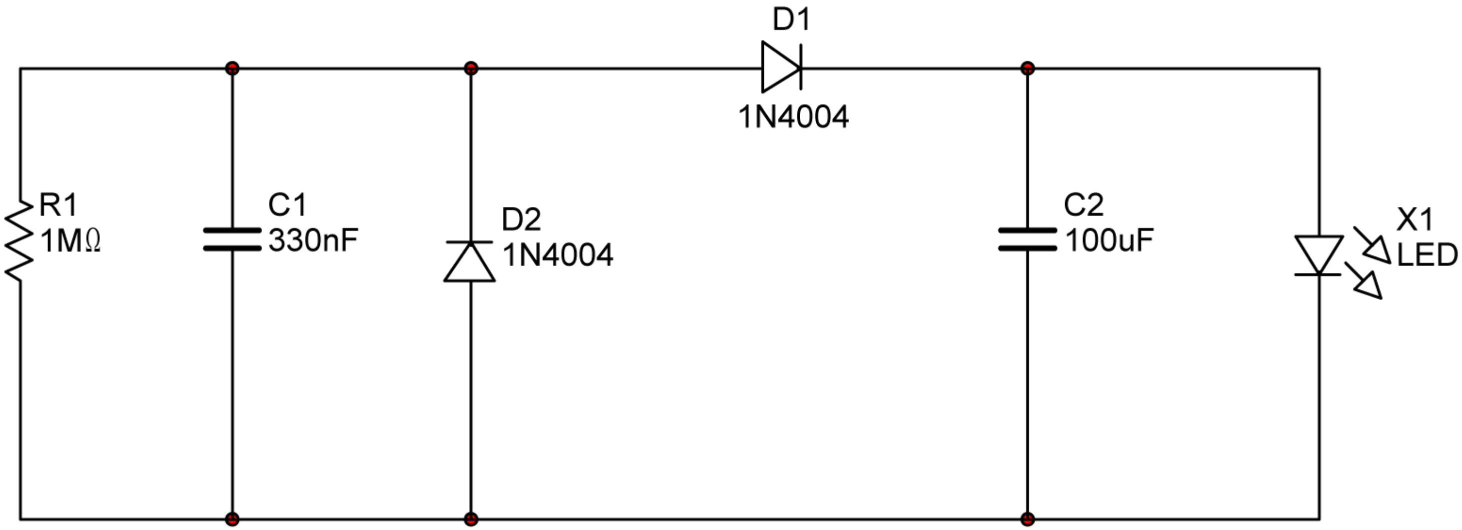
Input Circuit

- Kaleb Stunkard

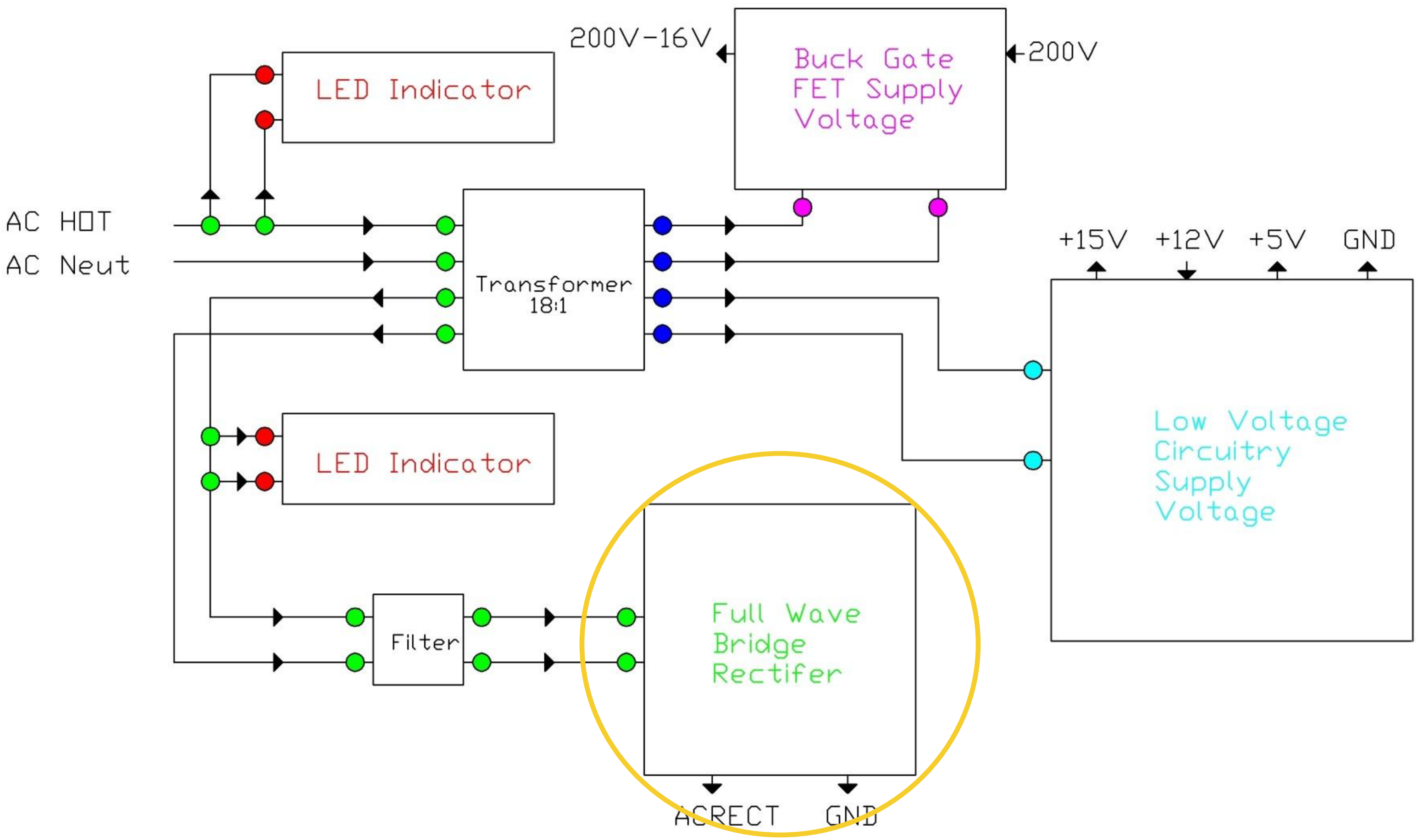
Input Power Block Diagram



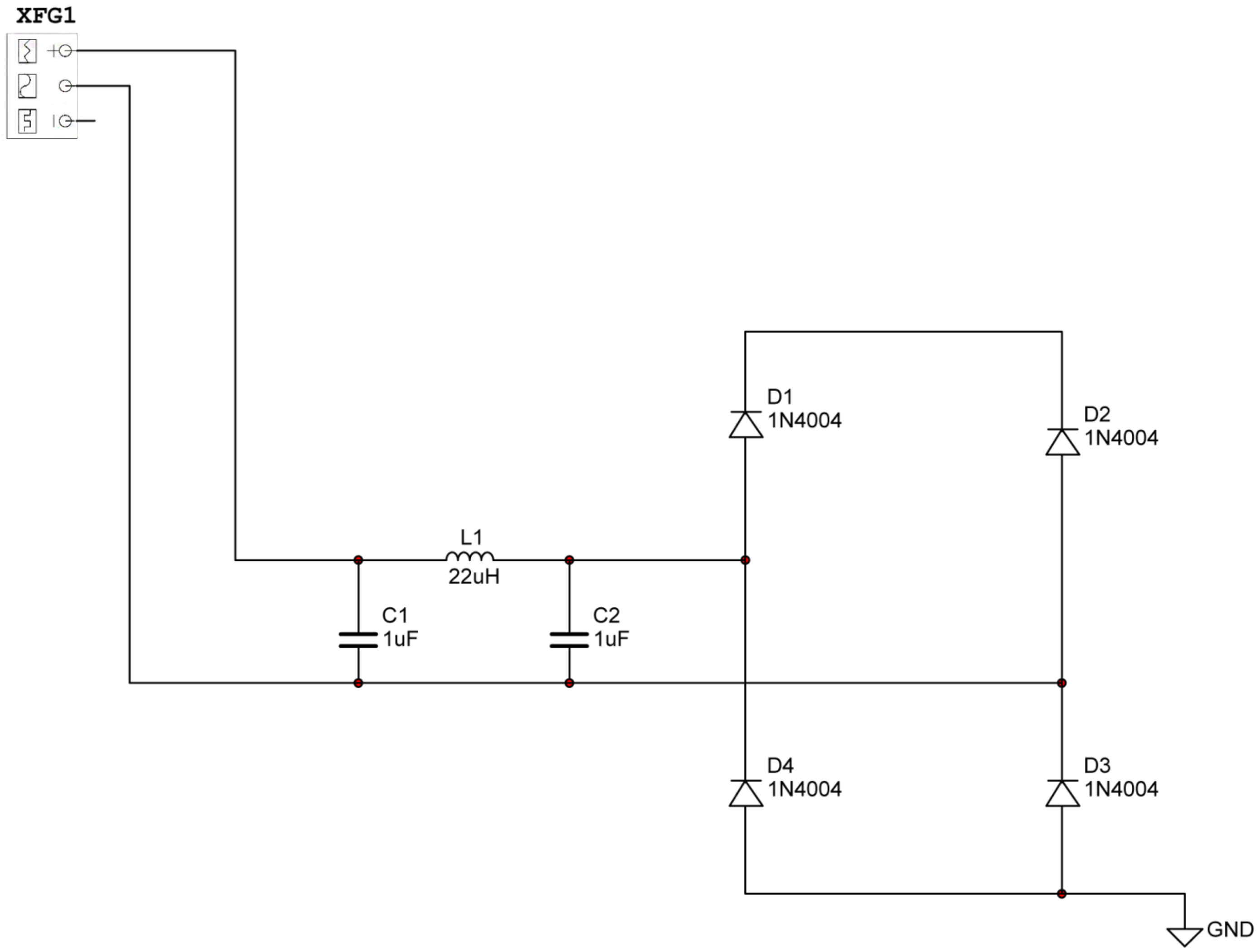
LED Indicator Schematic



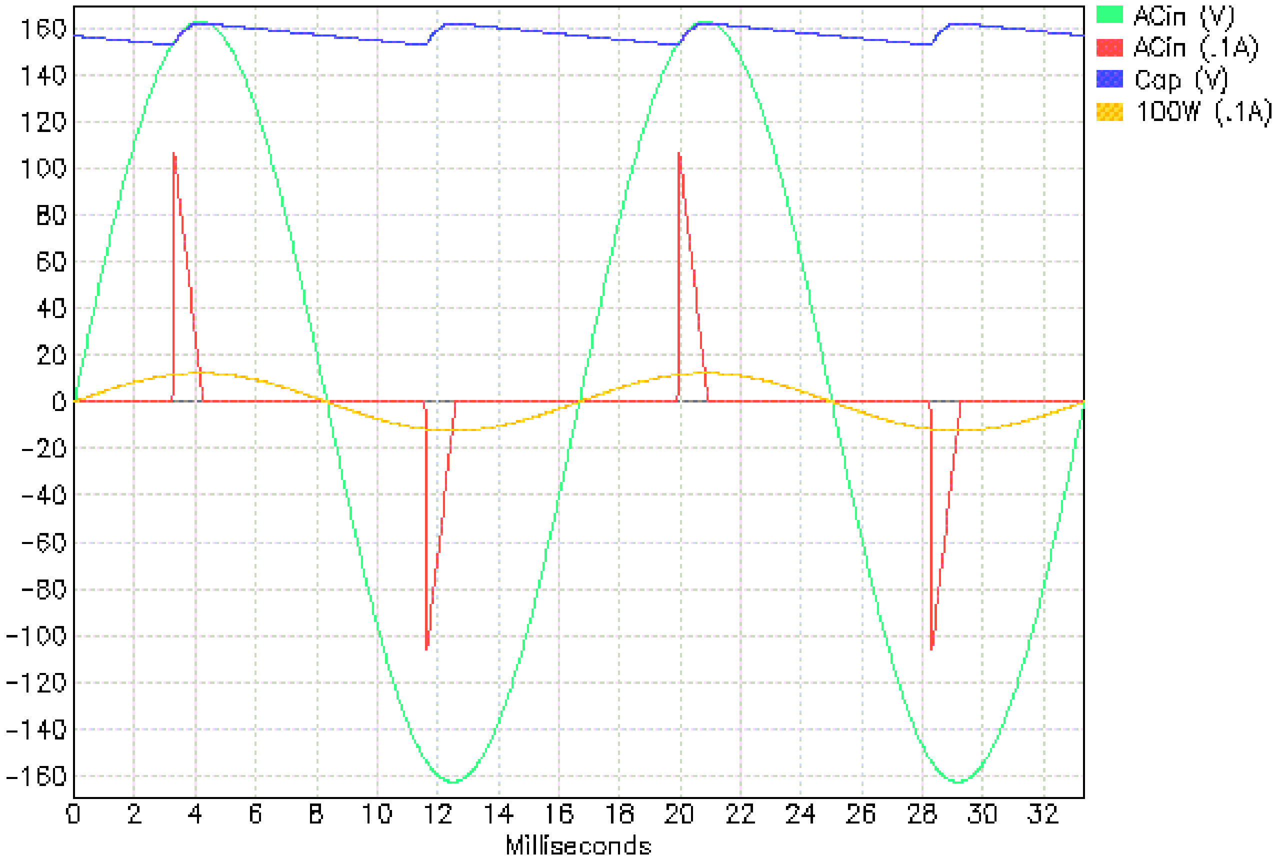
Input Power Block Diagram



Full Wave Bridge Rectifier Schematic

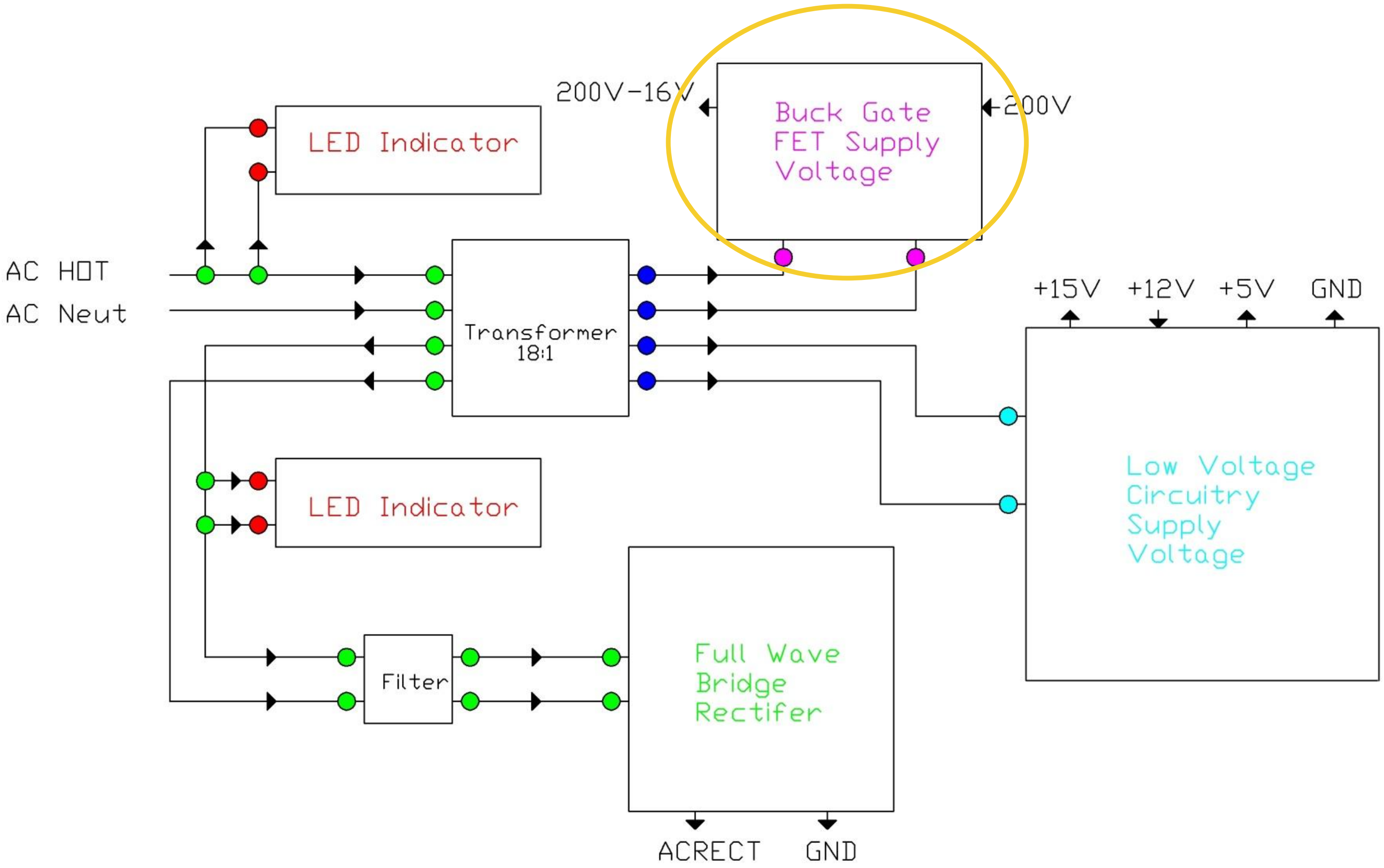


Why PFC?

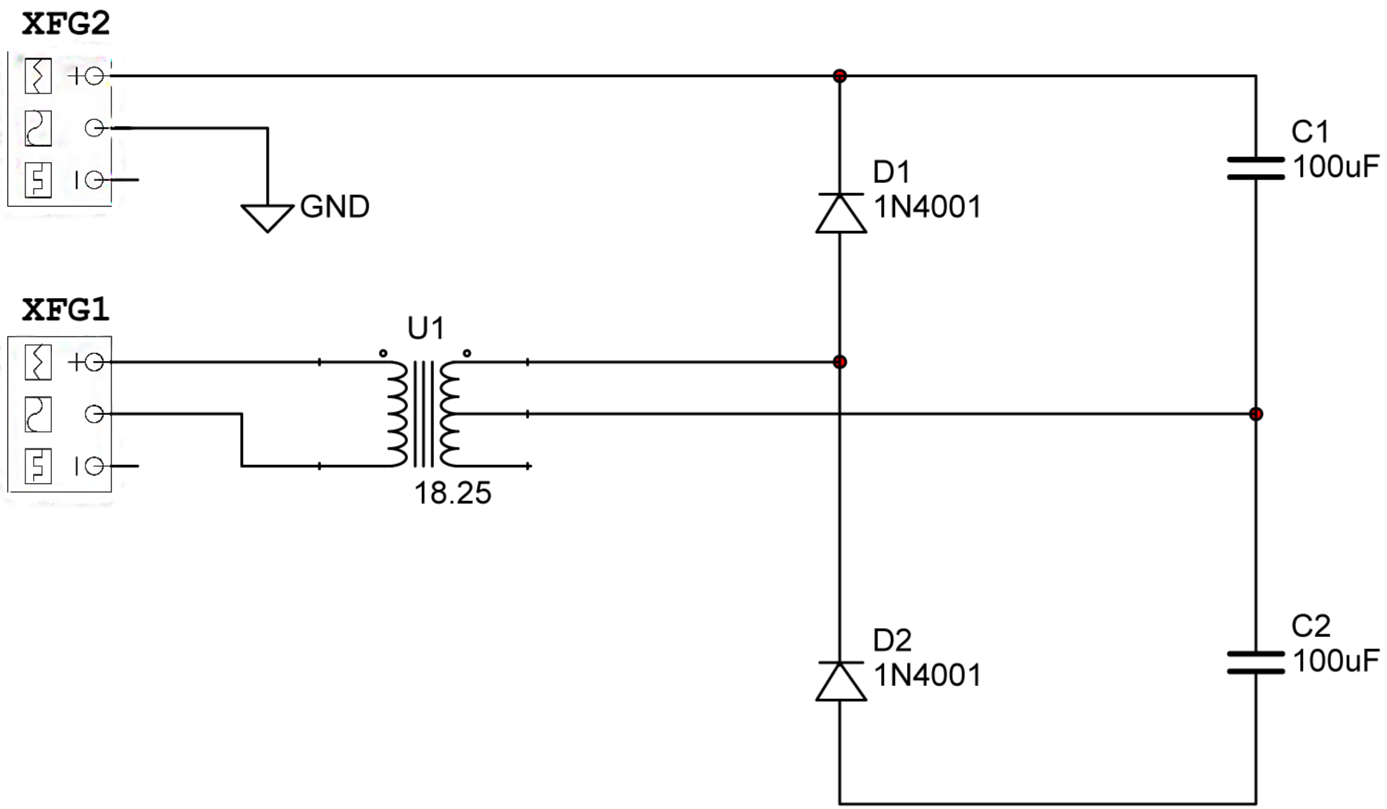


ACin (V)
ACin (.1A)
Cap (V)
100W (.1A)
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
Milliseconds

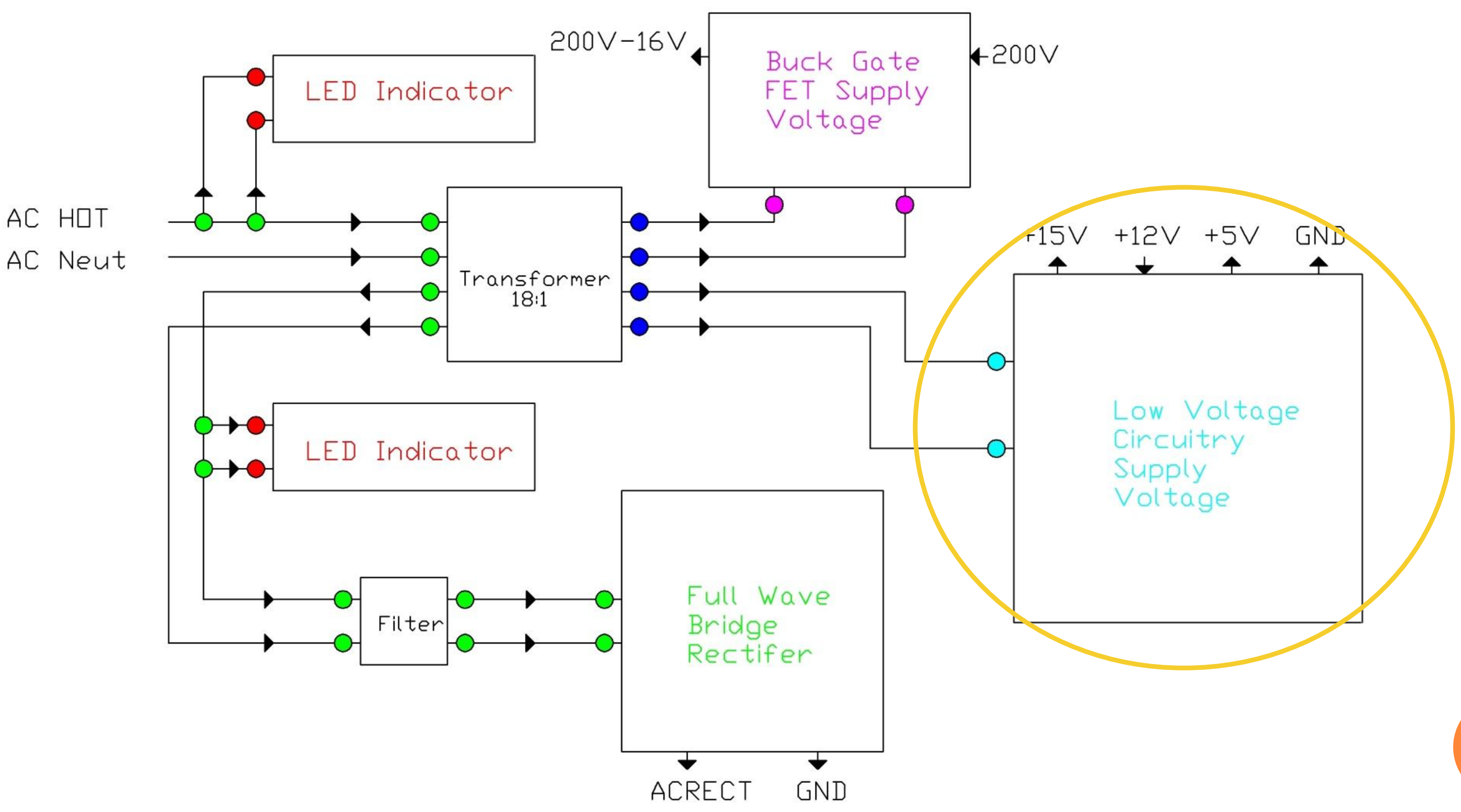
Input Power Block Diagram



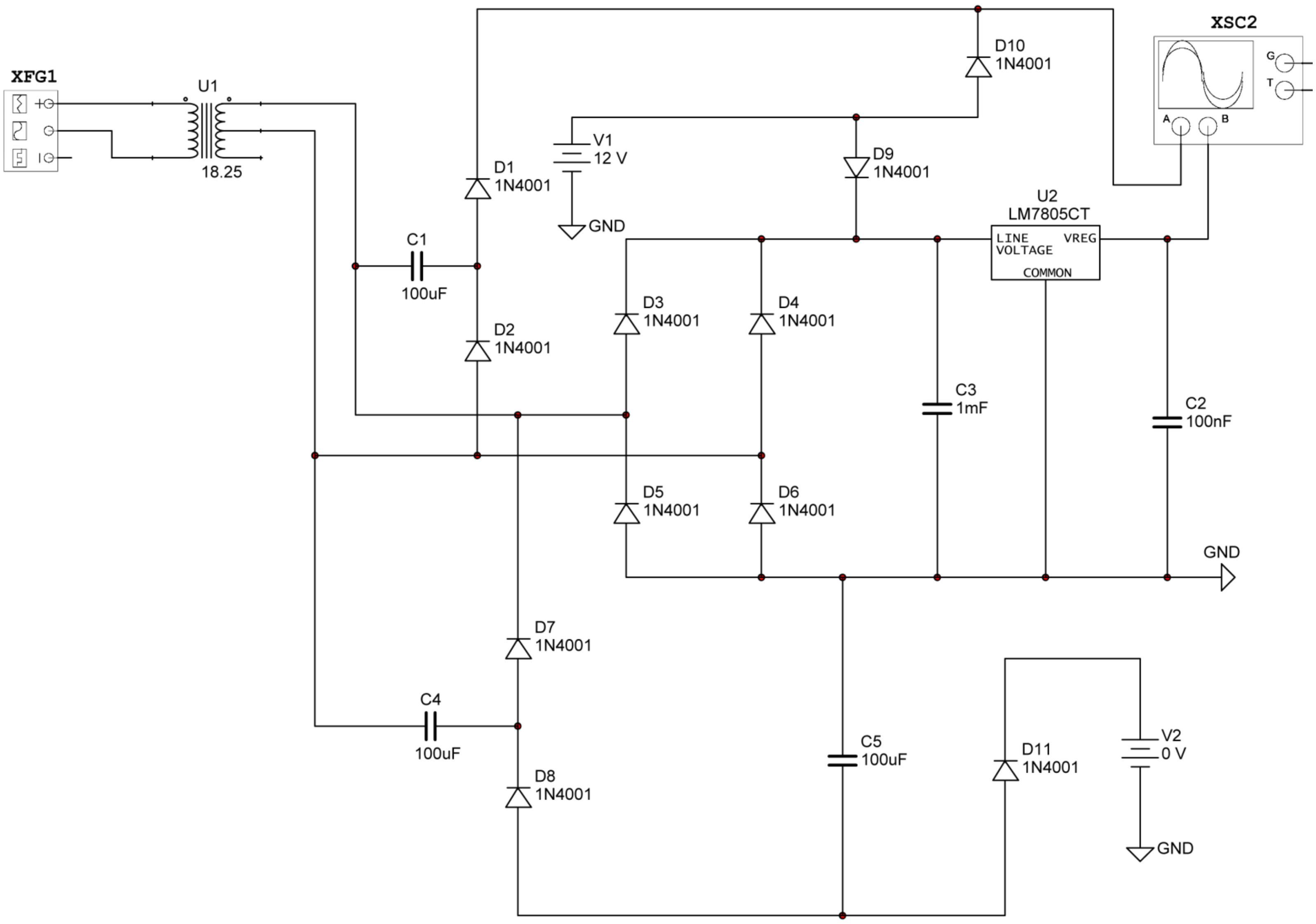
Buck Gate FET Supply Voltage Schematic



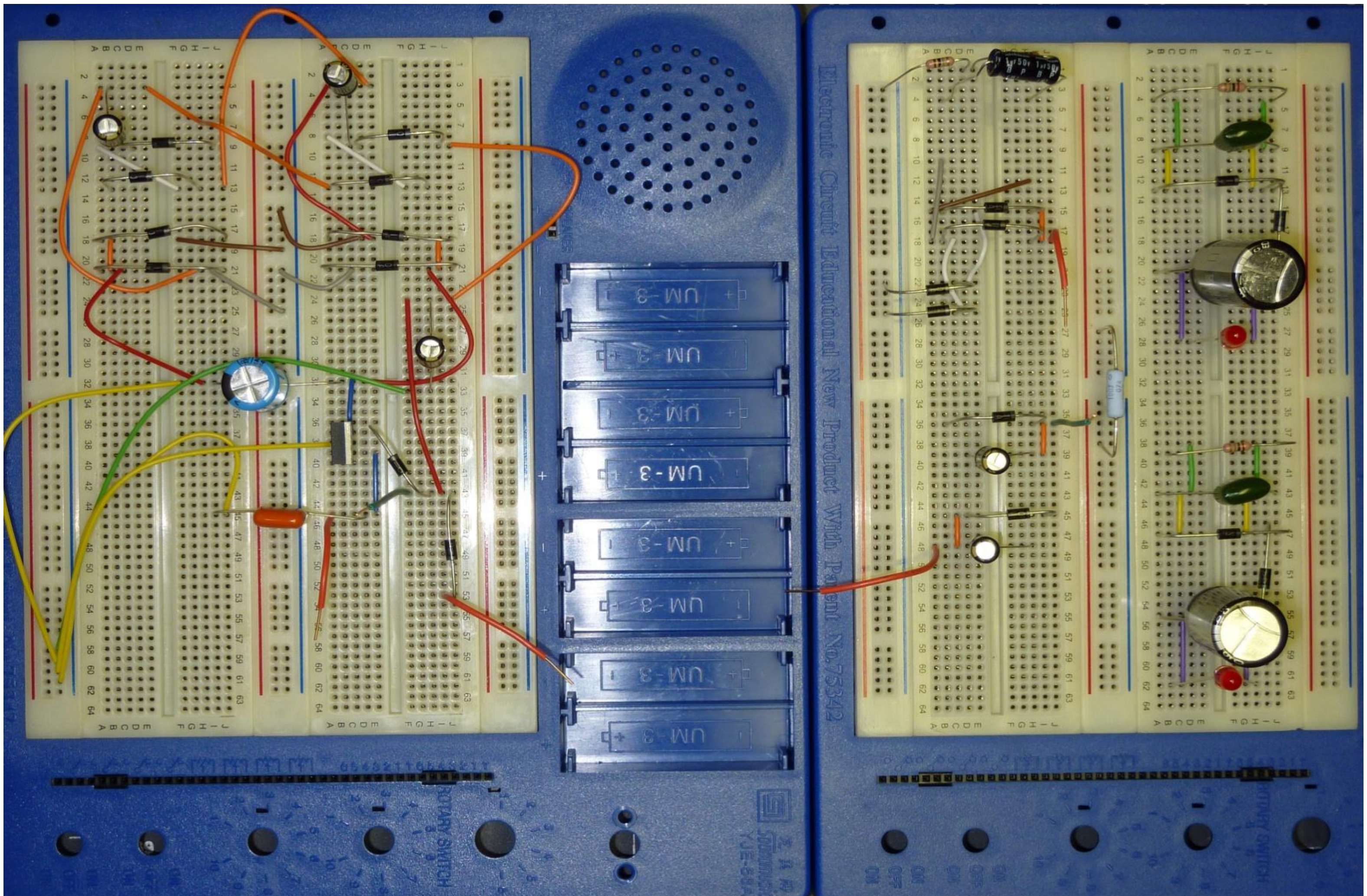
Input Power Block Diagram



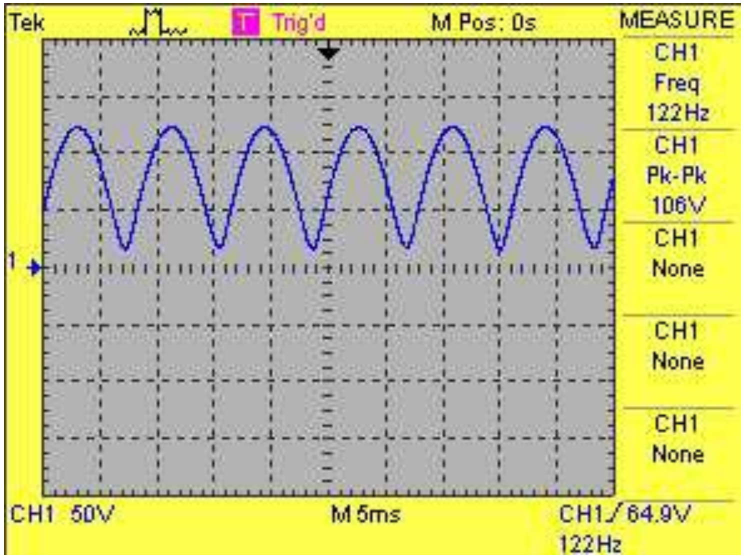
Low Voltage Circuitry Supply Schematic

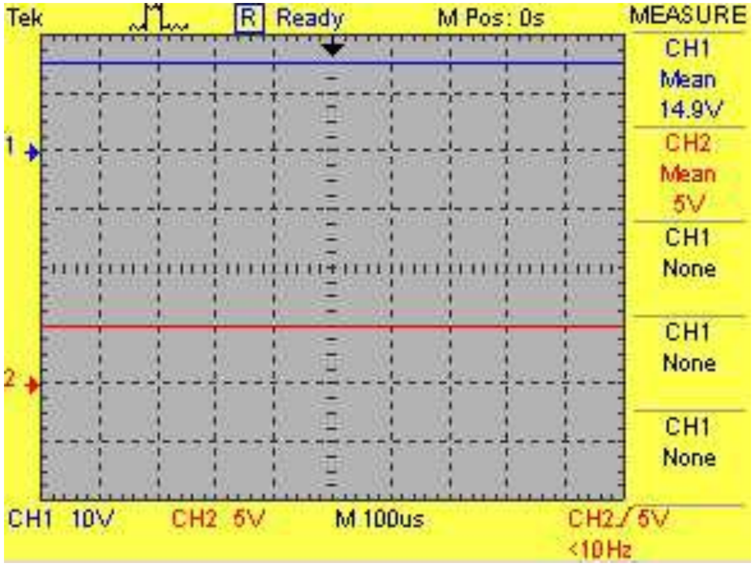


Input Power Prototype



Results (Rectified AC and Low Power Outputs)

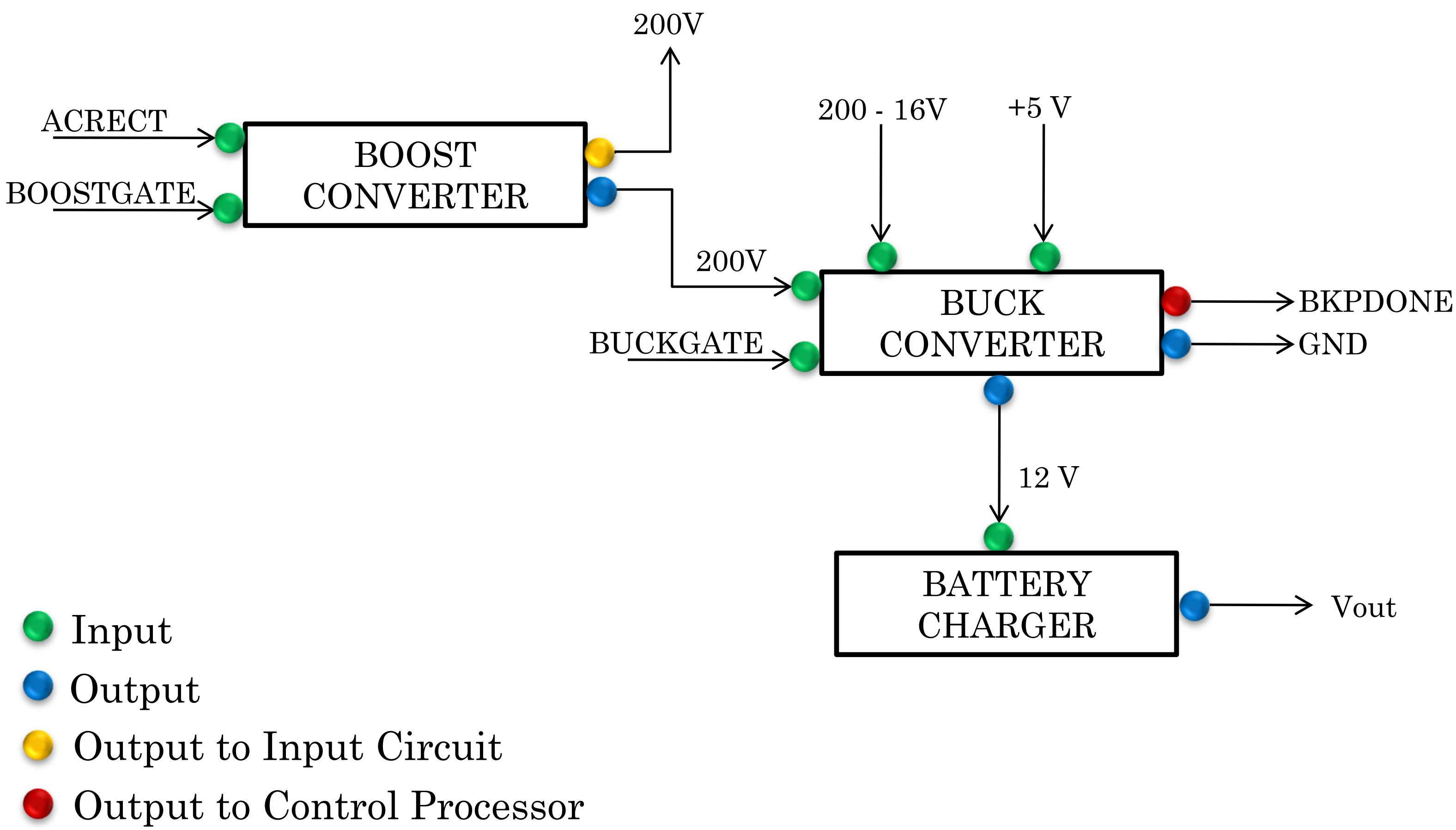




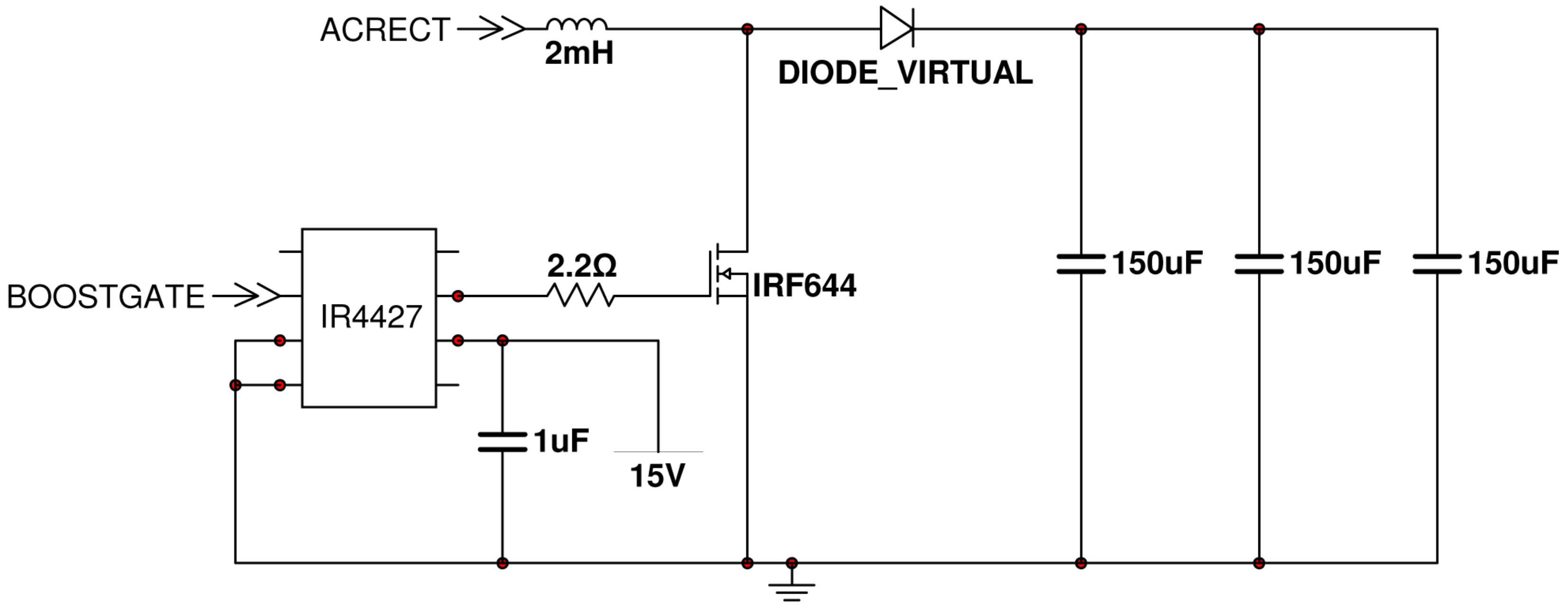
Boost Converter, Buck Converter & Battery Charging Circuit

- Jimit Shah

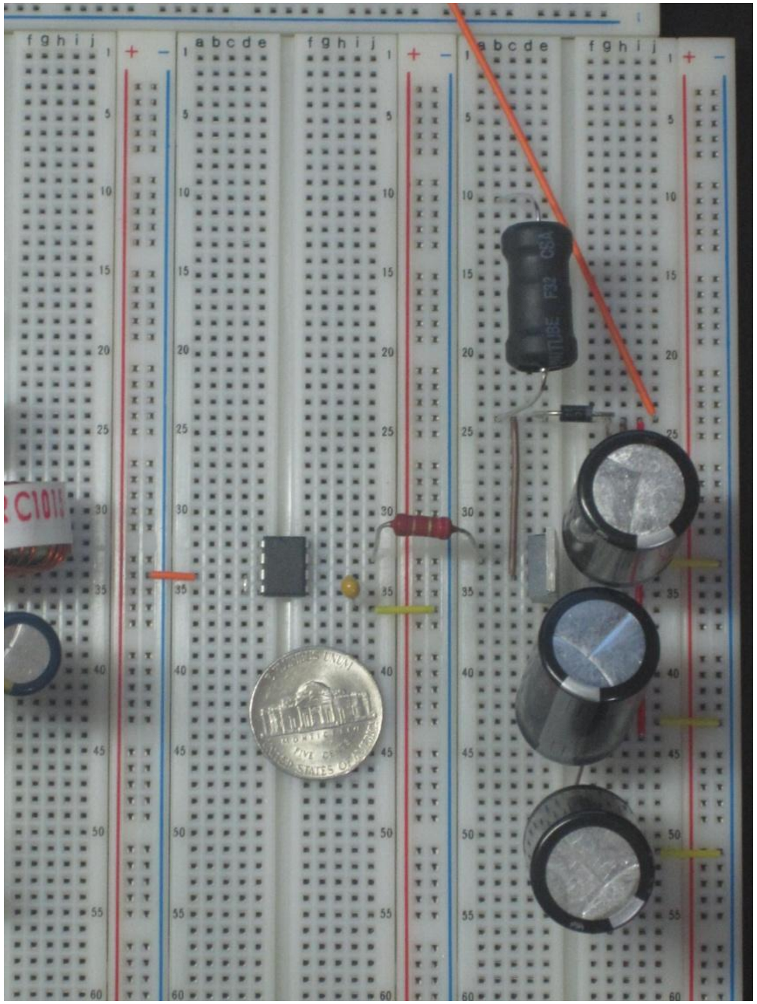
Block Diagram



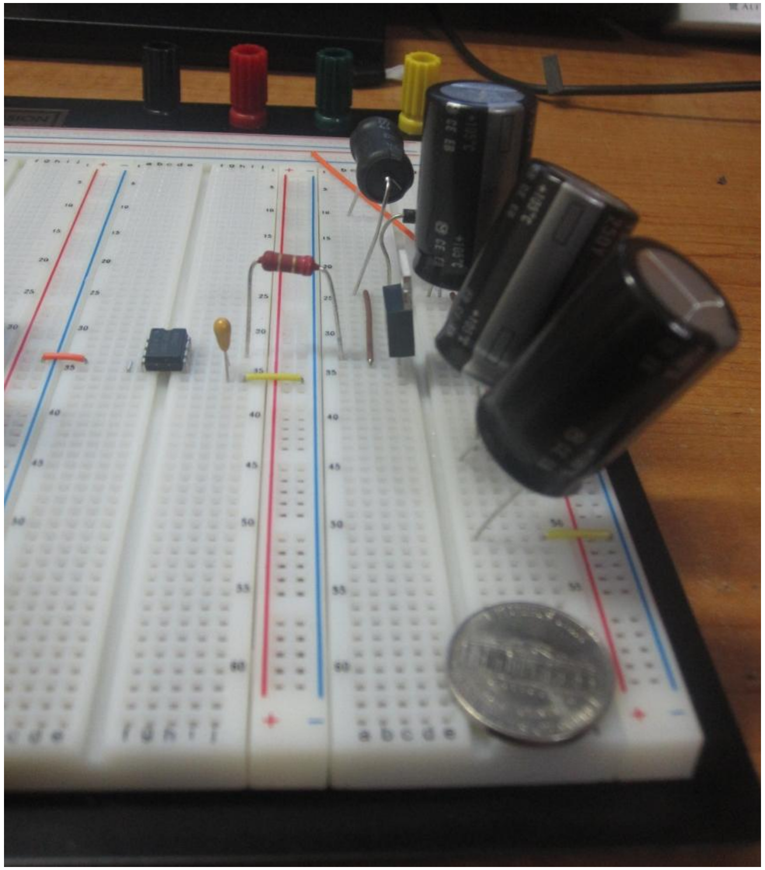
Boost Topology Schematic



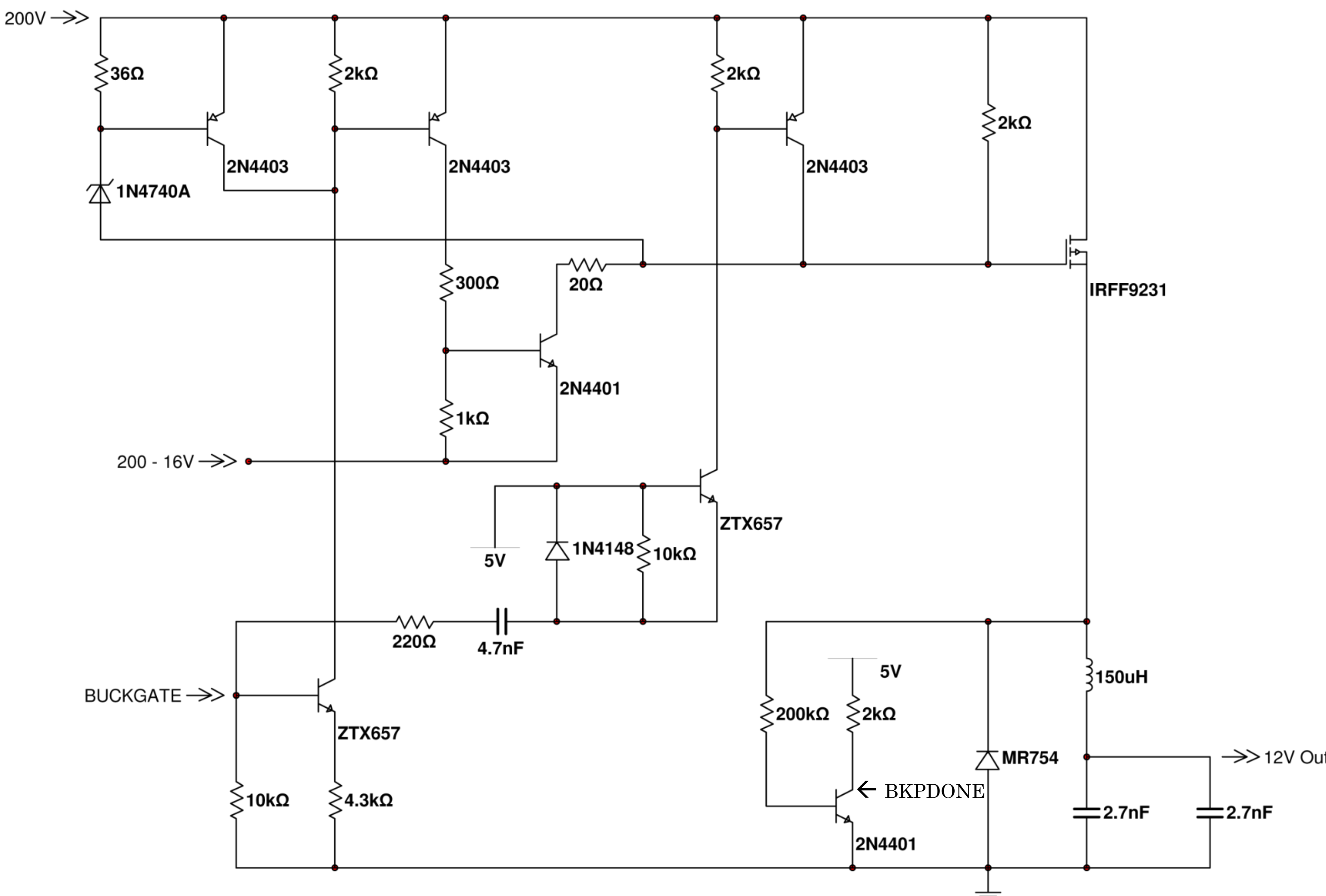
Top View



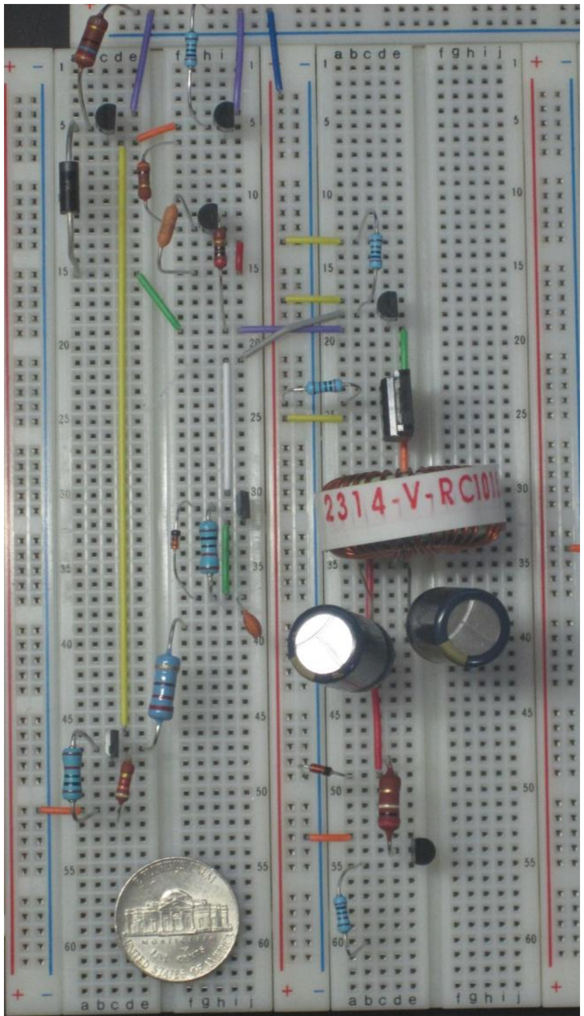
Side View



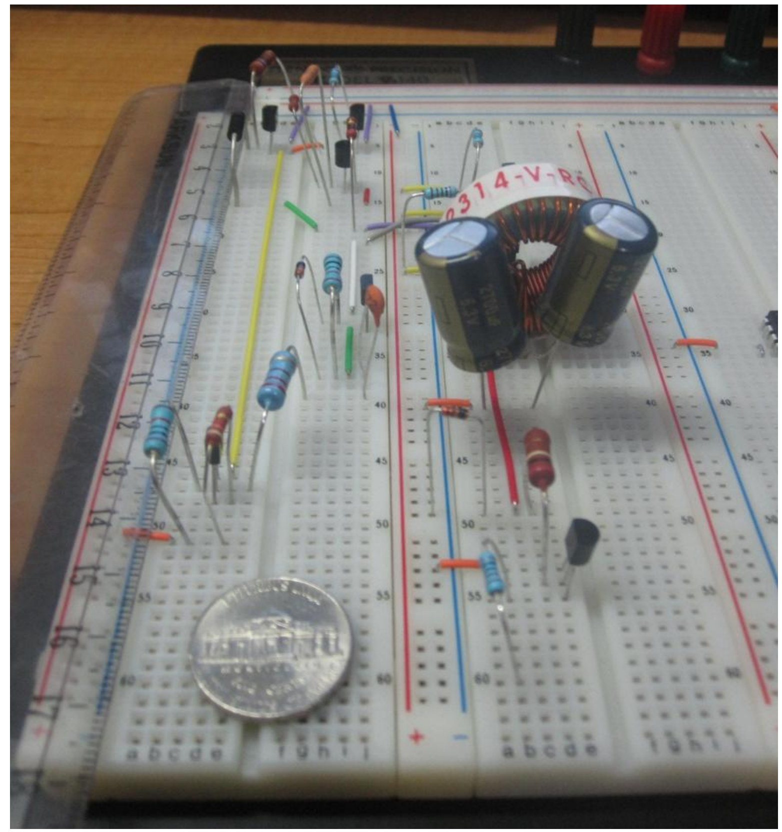
Buck Topology Schematic

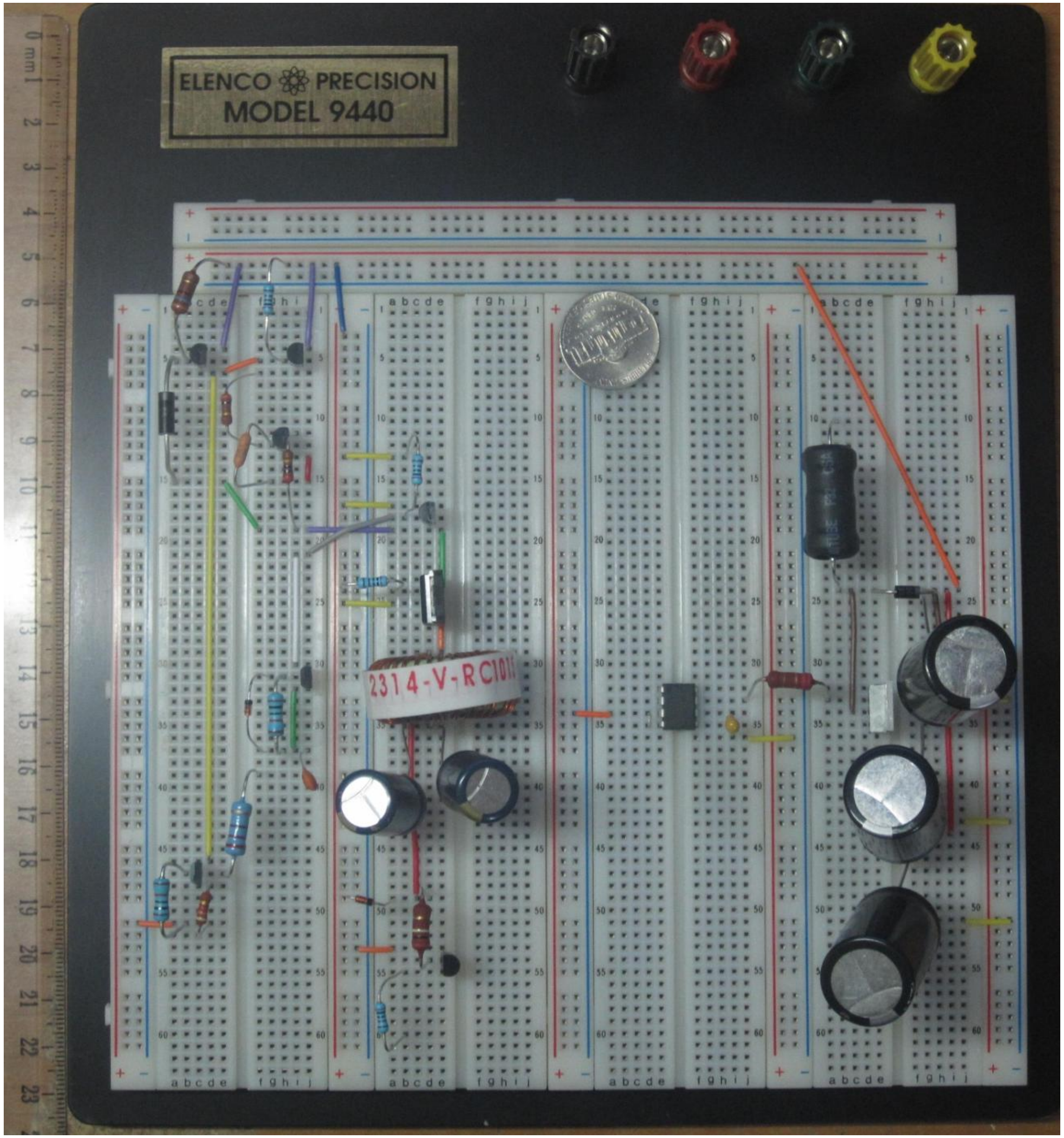


Top View

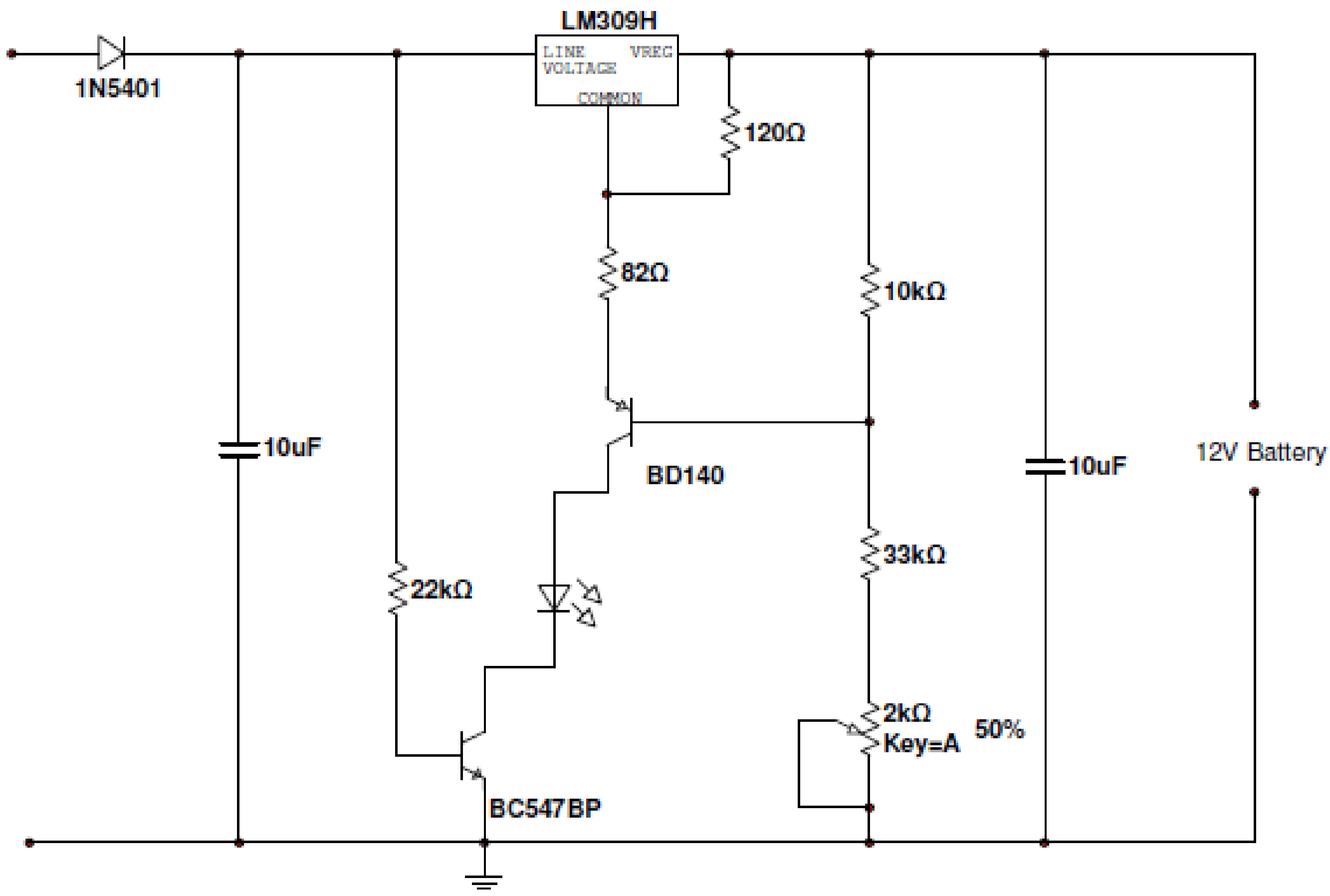


Side View




ELENCO PRECISION
MODEL 9440

Battery Charging Schematic



Microcontroller

- Louis Bengtson

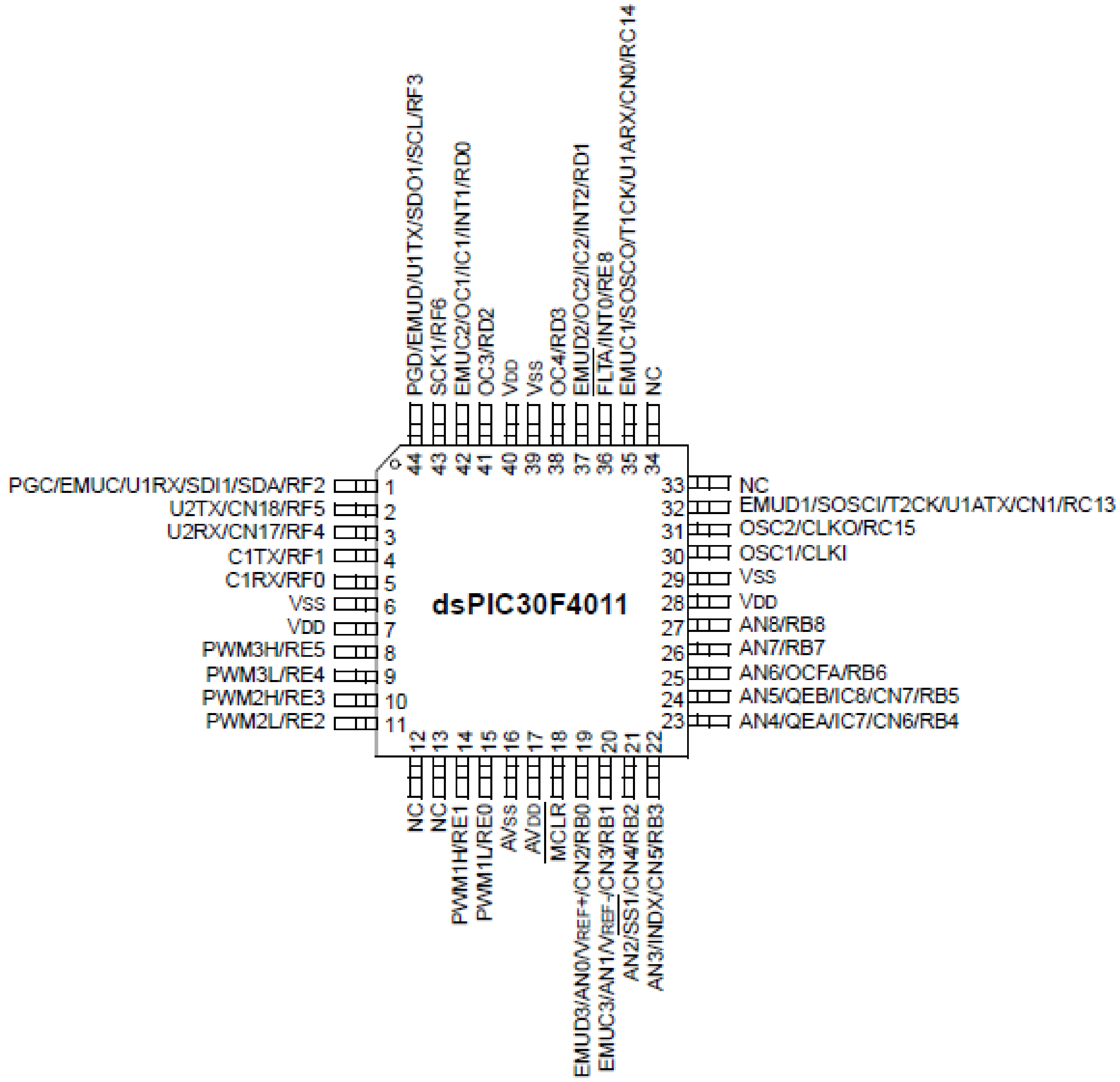
Advantages of dsPIC

- Extensive available parameters
- Inexpensive
- Programmable in C
- Compatibility with development tools
- Allows use of PFC algorithm
- Prospect of future improvements with digital control not possible with analog implementation

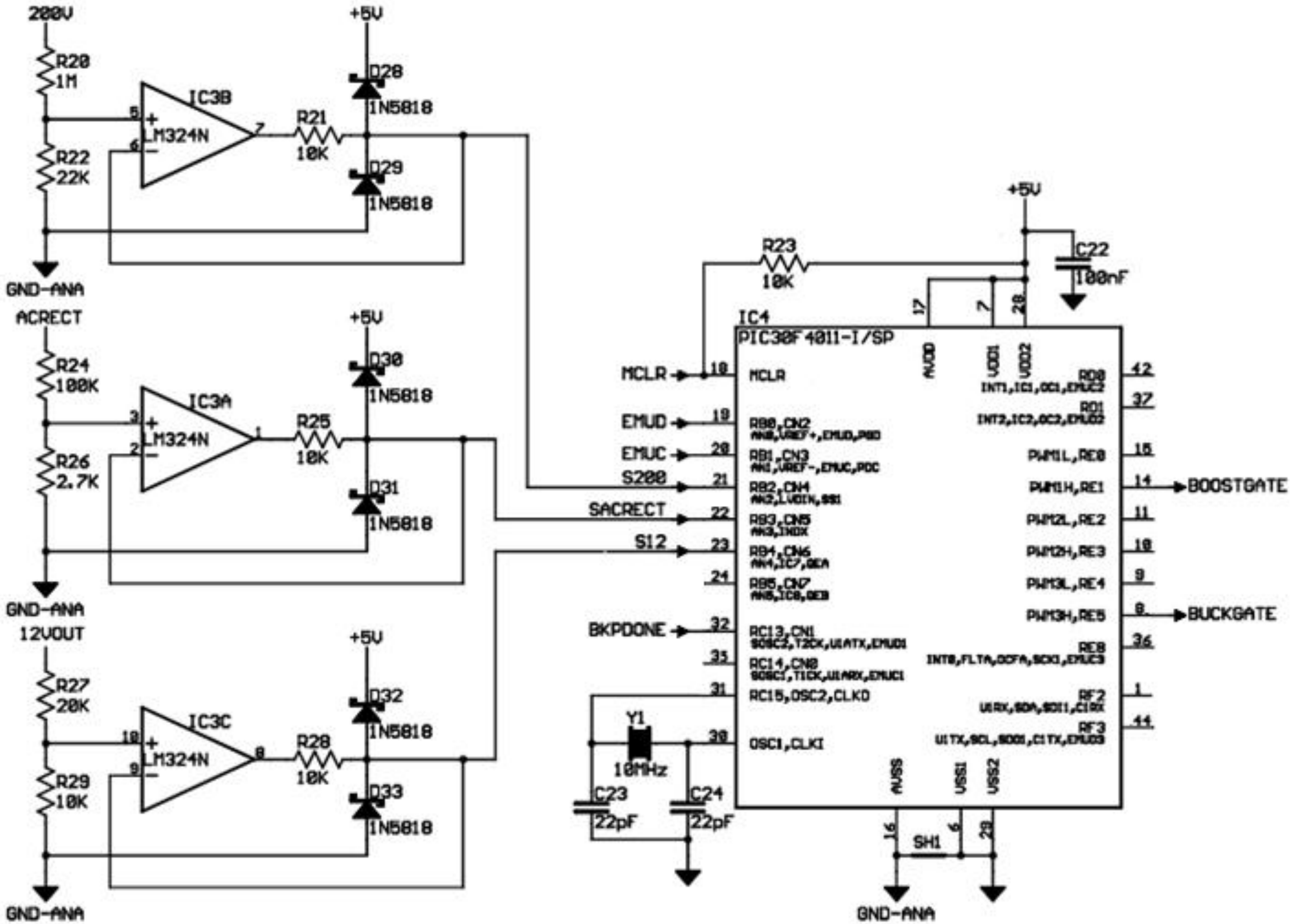
dsPIC30F4011 Specifications

Parameters	Values
Program Memory Type	Flash
Program Memory (KB)	48
CPU Speed (MIPS)	30
RAM Bytes	2048
Internal Oscillator	7.37 MHz, 512 kHz
nanoWatt Features	Fast Wake/Fast Control
Capture/Compare/PWM Peripherals	4/4
Digital Communication Peripherals	2-UART, 1-SPI, 1-I2C
Analog Peripherals	1-A/D 9x10-bit @ 1000(ksps)
Timers	5 x 16-bit, 2 x 32-bit
16-bit PWM resolutions	16
Motor Control PWM Channels	6
Temperature Range (deg C)	-40 to 125
Operating Voltage Range (V)	2.5 to 5.5
I/O Pins	30
Pin Count	44
Volume Pricing	$4.02

44-Pin TQFP



dsPIC30F4011
PGC/EMUC/U1RX/SDI1/SDA/RF2 1
U2TX/CN18/RF5 2
U2RX/CN17/RF4 3
C1TX/RF1 4
C1RX/RF0 5
VSS 6
VDD 7
PWM3H/RE5 8
PWM3L/RE4 9
PWM2H/RE3 10
PWM2L/RE2 11
NC 12
NC 13
PWM1H/RE1 14
PWM1L/RE0 15
AVSS 16
AVDD 17
MCLR 18
EMUD3/AN0/VREF+/CN2/RB0 19
EMUC3/AN1/VREF-/CN3/RB1 20
AN2/SS1/CN4/RB2 21
AN3/INDX/CN5/RB3 22
23 AN4/QEA/IC7/CN6/RB4
24 AN5/QEB/IC8/CN7/RB5
25 AN6/OCFA/RB6
26 AN7/RB7
27 AN8/RB8
28 VDD
29 VSS
30 OSC1/CLKI
31 OSC2/CLKO/RC15
32 EMUD1/SOSCI/T2CK/U1ATX/CN1/RC13
33 NC
NC 34
EMUC1/SOSCO/T1CK/U1ARX/CN0/RC14 35
FLTA/INT0/RE8 36
EMUD2/OC2/IC2/INT2/RD1 37
OC4/RD3 38
VSS 39
VDD 40
OC3/RD2 41
EMUC2/OC1/IC1/INT1/RD0 42
SCK1/RF6 43
PGD/EMUD/U1TX/SDO1/SCL/RF3 44



200V
R20
1M
R22
22K
GND-ANA
IC3B
LM324N
R21
10K
+5V
D28
1N5818
D29
1N5818
ACRECT
R24
100K
R26
2.7K
IC3A
LM324N
R25
10K
D30
1N5818
D31
1N5818
12VOUT
R27
20K
R29
10K
IC3C
LM324N
R28
10K
D32
1N5818
D33
1N5818
R23
10K
C22
100nF
IC4
PIC30F4011-I/SP
AVDD
VDD1
VDD2
MCLR
EMUD
EMUC
S200
SACRECT
S12
BKPDONE
RB0,CN2
RB1,CN3
RB2,CN4
RB3,CN5
RB4,CN6
RB5,CN7
RC13,CN1
RC14,CN0
RC15,OSC2,CLKO
OSC1,CLKI
RD0
RD1
PWM1L,RE0
PWM1H,RE1
PWM2L,RE2
PWM2H,RE3
PWM3L,RE4
PWM3H,RE5
RE8
RF2
RF3
BOOSTGATE
BUCKGATE
Y1
10MHz
C23
22pF
C24
22pF
AVSS
VSS1
VSS2
SH1

Microcontroller Functions

- Control buck and boost FET gate drivers
- Receive buck pulse done signal from buck converter to prevent new pulse while processing previous pulse
- Interrupt and compute next period boost pulse width for power factor correction between pulses

Boost Pulse Width Formula for PFC

$$\mathit{Boost\ Pulse\ Width} = \sqrt{\frac{2T_P L(V_O - V_{ac})}{V_O R}}$$

- T_p is the pulse period
- L is the Boost inductance
- R is the load resistance to the AC line
- V_o is the Boost output voltage
- V_{ac} is the instantaneous rectified AC voltage

Boost Pulse Width Algorithm

- Add 200V internal supply reading with boost diode drop voltage to acquire effective boost switcher output voltage
- Get rectified AC voltage reading and convert to 200V reading scale
- Subtract AC rectified voltage from effective boost switcher output voltage to obtain boost difference voltage
- If result is negative, clip at 0
- Divide boost difference voltage by boost output voltage to obtain duty cycle
- Take the square root to obtain scaled pulse width, and restore original scale
- Compare computed duty cycle to maximum duty cycle
- If computed duty cycle is out of range, set maximum duty cycle
- Set boost switcher pulse width for the next PWM period

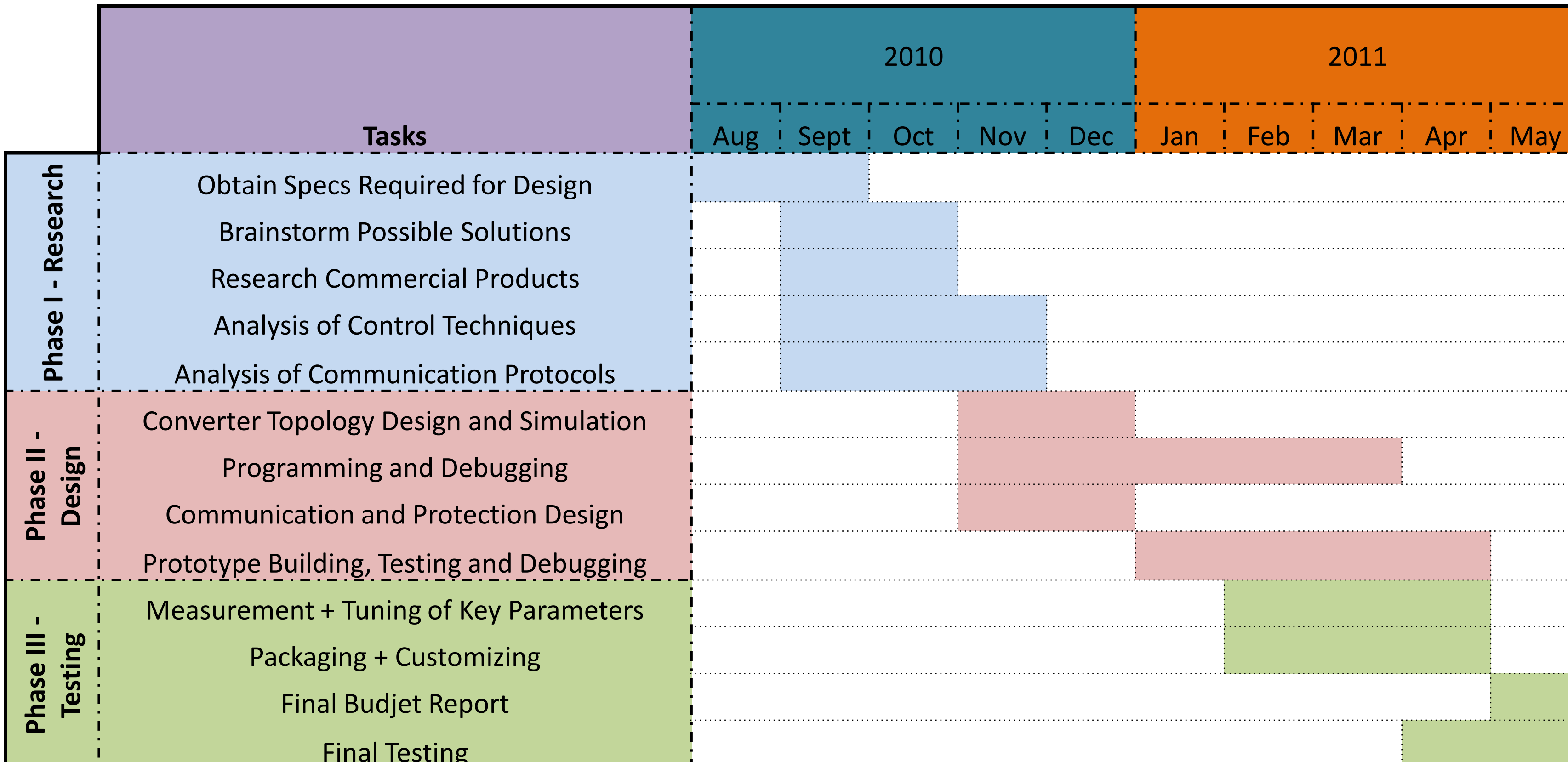
Anticipated Problems

- Generator performance
- GPS
- Not being able to test Boost & Buck circuits
- Programming the microcontroller
- Integrating microcontroller chip into PCB
- PCB layout

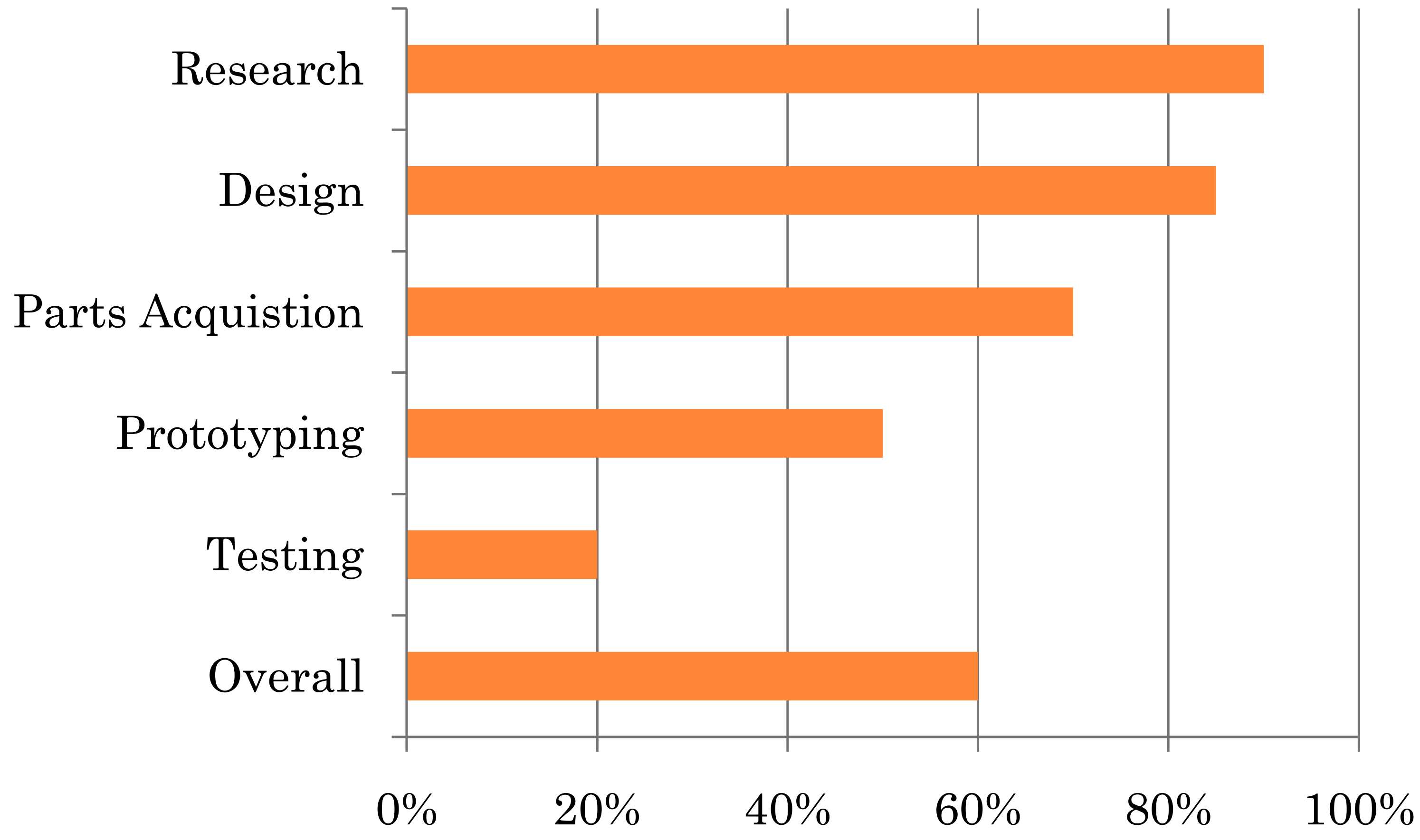
Budget

Item Description	Cost	% of Total Project Cost
Resistors	$5.56	0.70%
Capiators	$41.34	5.27%
Inductors	$31.92	4.06%
Diodes	$12.51	1.60%
Transistors	$15.35	1.95%
LEDs	$2.98	38.00%
Lead Acid Battery	$18.06	2.30%
Microcontroller	$31.90	4.06%
Blank MCU Cards	$56.60	7.20%
Breadboards	$64.89	8.26%
Breadboard Jumper Kits	$12.82	1.63%
Development Kit	$467.00	59.40%
Multimeter	$24.50	3.12%
	$785.43	

Project Timeline



Milestone Chart



QUESTIONS?