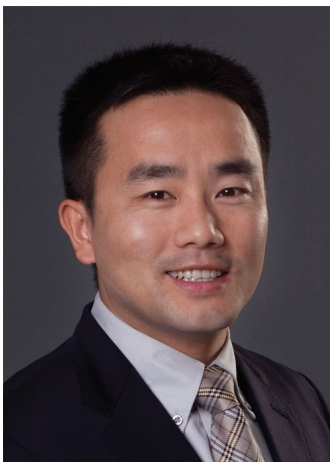


Announcements

- TBC: Design comparison due Friday
 - Afterwards, begin PCB layout (as group)
 - Due Friday, Nov. 2nd
- Guest lecture this Friday

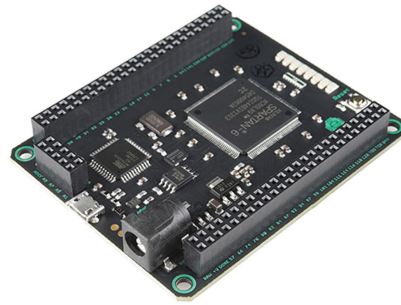
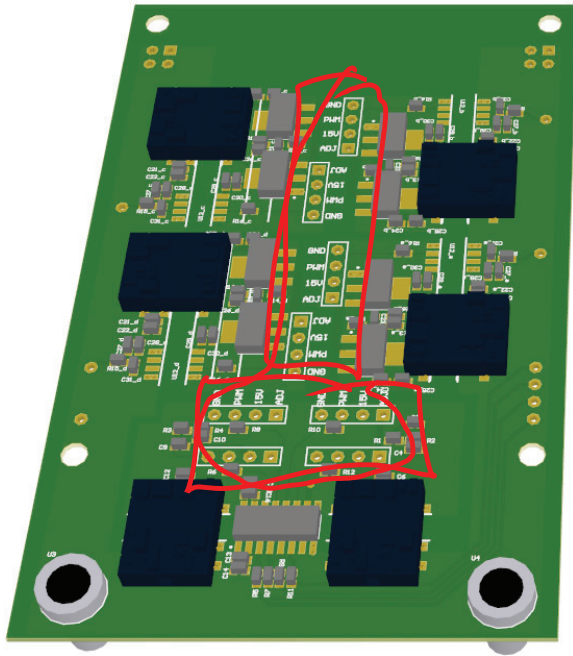
Guest Lecture Friday 10/26



This presentation summarizes our activities in the areas of energy management and megahertz wireless power transfer, especially at system-level designs and control aspects. Modeling and control of a hybrid energy system are first explained. Multi-agent modeling and game theory-based control are proposed and combined as a general solution for the energy management of such multi-source energy systems. This unique solution fully respects and balances different preferences of components, and thus improves scalability and performances at both component-level and system-level. Problem of managing a larger energy system, such as a microgrid with renewable energy, energy storage, and plugged-in electric vehicles (EVs), is further formulated to reflect EV's charging priority, driver's price sensitivity and range anxiety. A new direction on demand-side management of spatial and temporal distributions of EV fleet charging and its framework will also be mentioned.

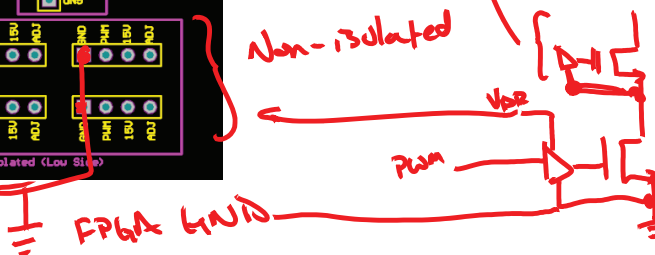
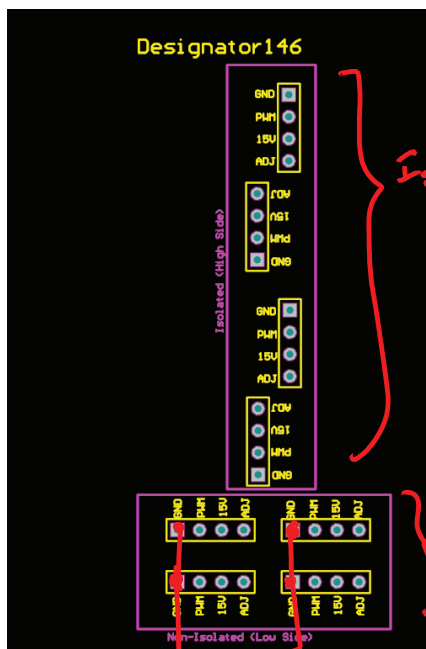
Chengbin Ma received the B.S. degree in industrial automation from East China University of Science and Technology, Shanghai, China, in 1997, and the M.S. and Ph.D. degrees in electrical engineering from The University of Tokyo, Tokyo, Japan, in 2001 and 2004, respectively. From 2004 to 2006, he was an R&D Researcher with the Servo Motor Laboratory, FANUC Limited, Japan. Between 2006 and 2008, he was a Postdoctoral Researcher with the Department of Mechanical and Aeronautical Engineering, University of California, Davis, USA. He joined the University of Michigan–Shanghai Jiao Tong University Joint Institute, Shanghai Jiao Tong University, Shanghai, China, in 2008, and currently an Associate Professor of electrical and computer engineering. His research interests include energy management, megahertz wireless power transfer, dynamics and motion control, and wide applications in electronic devices, electric vehicles, microgrids, smart grids, etc.

Modulation Signal Board

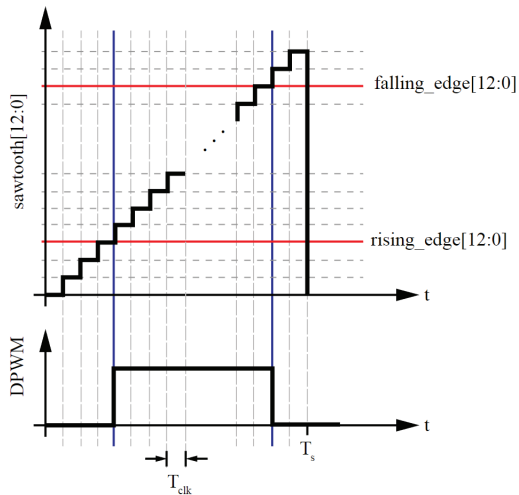


- Mates on Mojo v3 (stacked headers)
- 4-pin (male) header connections
- Layout in Altium starter package on course website

Starter File Footprints



FPGA Code



Further tutorial:

<http://web.eecs.utk.edu/~dcostine/ECE581/Fall2018/TinyBox/FPGA/>

```
//Digital sawtooth generator. One is shared by all
modulator to ensure the sawtooths themselves are in
phase
sawtooth_gen sawtooth_gen (
    .max_mod_value(300),
    .rst(rst),
    .clk(clk300),
    .sawtooth(sawtooth)
);

//8 individual PWM modulators. To turn any of them
off, just change
//    .rst(rst),
//to
//    .rst(~rst),

//FPGA pin 124
modulator_single gL0 (
    .sawtooth(sawtooth),
    .falling_edge(298),
    .rising_edge(152),
    .rst(rst),
    .clk(clk300),
    .DPWM(gL[0])
);

//FPGA pin 127
modulator_single gL1 (
    .sawtooth(sawtooth),
    .falling_edge(150),
    .rising_edge(1),
    .rst(rst),
    .clk(clk300),
    .DPWM(gL[1])
);
```

...

Deliverables Next Friday

- Login info to account with PCB layout that has passed Sierra Circuits' AFV with
 - 6 mil spacing
 - 15 mil holes
 - 4-day turn
 - 2 boards
 - Up to 4 layers
- Excel spreadsheet of all parts, showing \$100 requirements met
- Total \$300 for components & PCB
- **Actionable** ordering links/quotes for all parts

Quote Specifications



CALL US
(800) 763.7503

INSTANT
QUOTE

LIVE
CHAT

Instant Quote: No Touch PCBs.

Now, RoHS-compliant (lead-free material and surface finish)

[What is No Touch?](#)

| | | |
|---|---|--|
| Layers | <input type="text" value="4"/> layers | |
| True Turn Time (Business Days) | <input type="text" value="4"/> Days | Cut off time is 5 PM Pacific Time. When will my boards ship if I order today? |
| Quantity | <input type="text" value="2"/> 2 boards | Select Quantity (up to 100 pieces). |
| Show additional quantities More | | |
| Board Dimensions | <input type="text" value="2.503"/> (in.) X <input type="text" value="3.916"/> (in.) | Please enter EXACT dimensions (e.g., 3.12 X 4.55) |
| Minimum Finished Hole Size | <input type="text" value="15"/> mils (0.015"), Standard | |
| Minimum Trace / Space | <input type="text" value="6"/> mils (0.006"), Standard | No Touch now allows down to 4 mils trace/space! |

[Get Quote](#) >

[Terms & Conditions And Product Specs](#) [More](#)



CALL US
(800) 763.7503

INSTANT
QUOTE

LIVE
CHAT

[No Touch / AFV Status Page](#) [What is AFV?](#)

To see your saved internet quotes, click here
Currently viewing ALL your AFV runs.

To see the latest Process Status of your files, please refresh this page.

[Main Folder](#)
[Hide/Old Folder](#)
[View last 25](#)
[Click to refresh this page](#)

You are viewing the Main folder

| File Name | File Verification# | Part Number Rev | QTY | Board Dims (inches) | Process Status | Overall Status | Order/ Report |
|---|---|-----------------|-----|---|----------------|-------------------------------|-----------------------|
| 581Driver.zi p Oct 23 2016 3:15 PM PST | afv1-144682 Board Construction Summary | 581Driver 1 | 2 | Customer 2.503 X 3.916 AFV 2.503 X 3.916 | completed | File Review Done - Successful | Order |

[Move to Hide Folder](#)
[Move selected items to the Hide folder]

LEARN

[About Us](#)
[Certifications](#)
[PCB Manufacturing Capabilities](#)

BUY

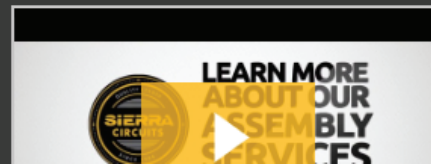
[NoTouch PCBs](#)
[Web PCBs](#)
[PCB Assembly](#)

TOOLS

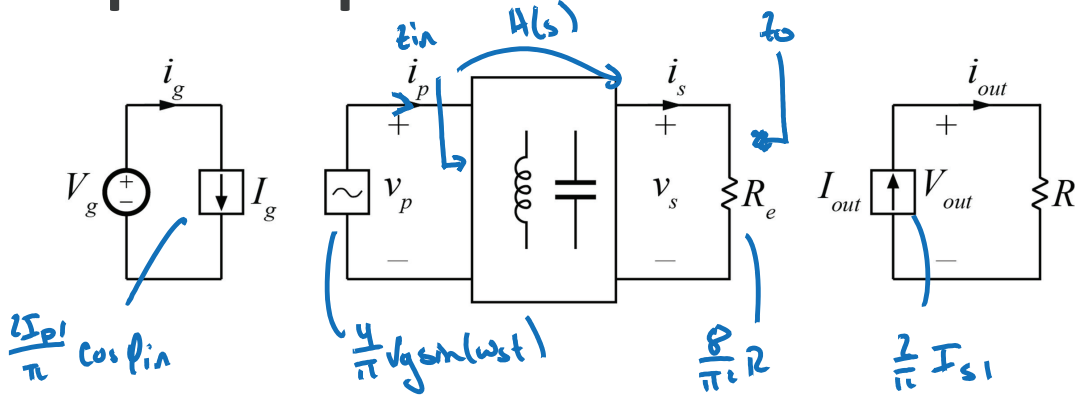
[HDI Stackup Planner](#)
[Material Selector](#)
[Better DFM](#)

DOWNLOADS

[Capabilities Brochure](#)
[PCB Assembly Brochure](#)
[Microelectronics Brochure](#)



Complete Equivalent Circuit



$\phi_{in}, I_{p1}, I_{s1}$ determined by complete circuit

$$M = \frac{V_{out}}{V_g} = \frac{V_{out}}{I_{out}} \cdot \frac{I_{out}}{I_{s1}} \cdot \frac{I_{s1}}{V_{s1}} \cdot \frac{V_{s1}}{V_{p1}} \cdot \frac{V_{p1}}{V_g}$$

$$M = \cancel{R} \cdot \cancel{\frac{2}{\pi}} \cdot \frac{1}{\cancel{\frac{8}{\pi} R}} \cdot \|H(j\omega_s)\| \cdot \cancel{\frac{4}{\pi}}$$

keep in mind $z_{in}, H(s), z_o$ depend on R_e

$$M = \frac{V_{out}}{V_g} = \|H(j\omega_s)\|$$

Tank Input Impedance

SRC example

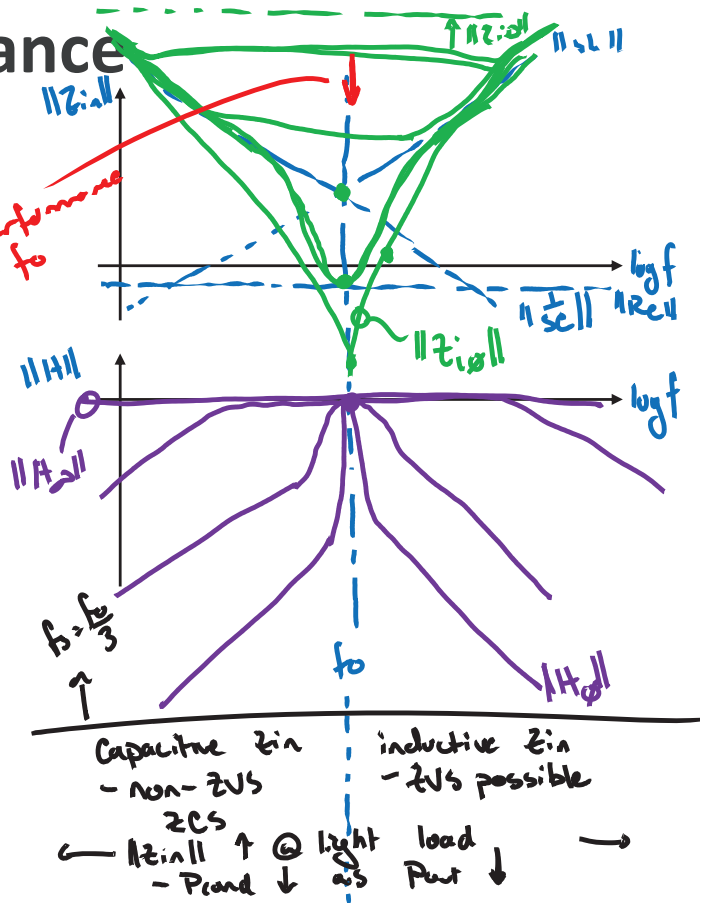
$$z_{in}(s) = sL_p + \frac{1}{sC_r} + R_e$$

$$H(s) = \frac{R_e}{z_{in}(s)}$$

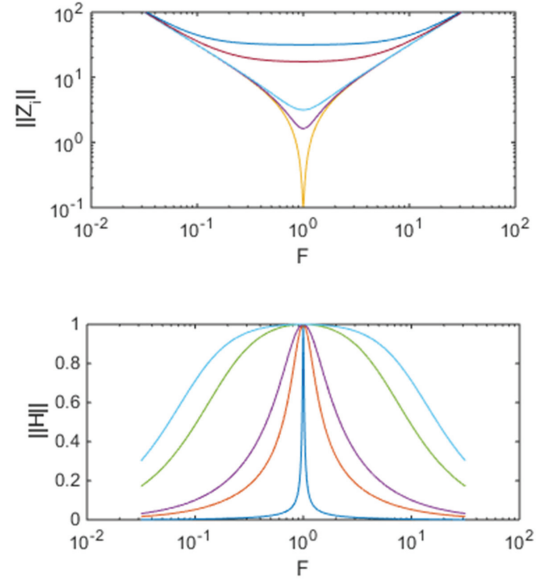
$$\|z_{in}\| \rightarrow \|z_i, R_e \rightarrow \phi\|$$

$$\|z_{in}\| \rightarrow \|z_i, R_e \rightarrow \infty\|$$

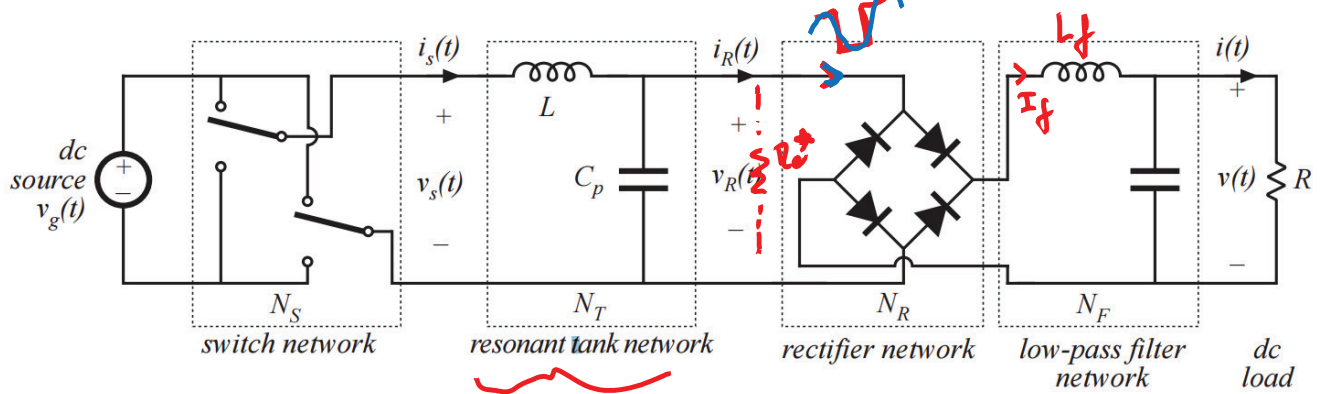
Sinusoidal approximation valid when
 - $R_e \ll \omega$
 - $f_s \approx f_0$



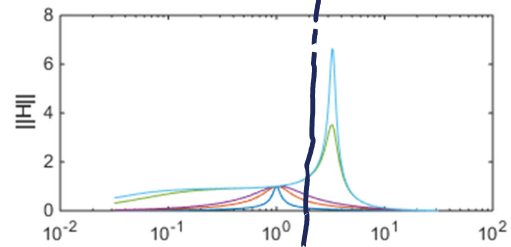
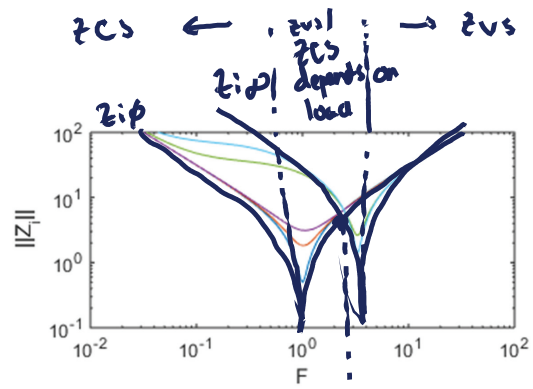
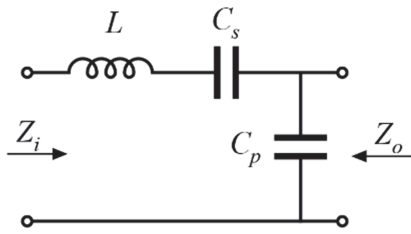
Series Resonant Tank



Parallel Resonant Converter

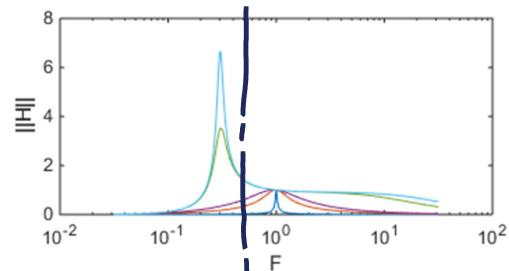
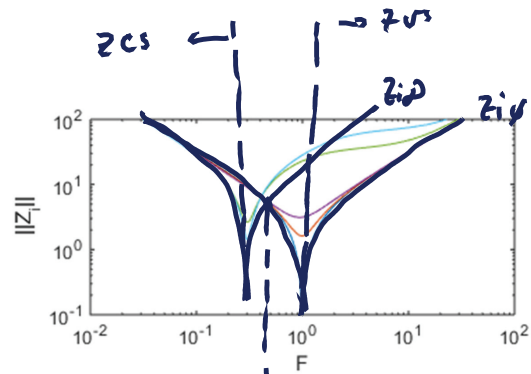
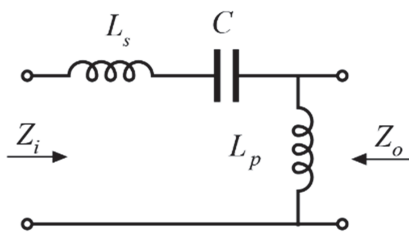


LCC



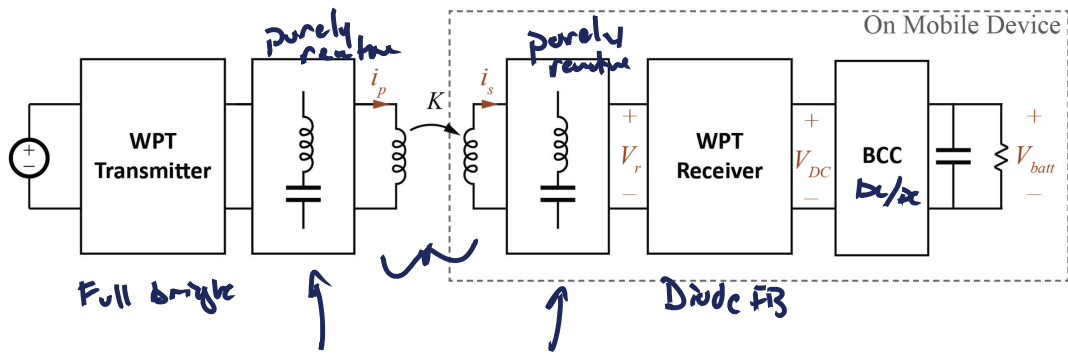
$P_{cond} \uparrow$ @ heavy load ✓
 $P_{cond} \downarrow$ @ light load X

LLC

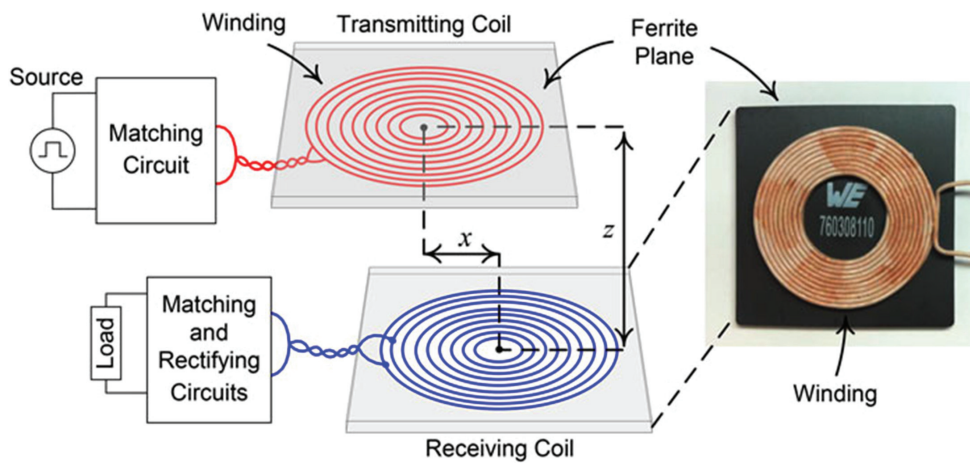


$P_{cond} \uparrow$ @ light load ✓
 $P_{cond} \downarrow$ @ heavy load X

Wireless Power Transfer



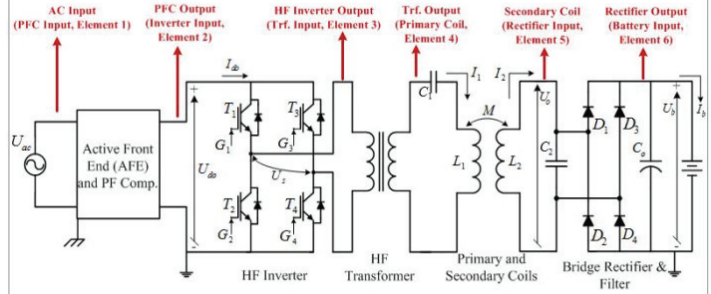
Mobile Device WPT



EV WPT

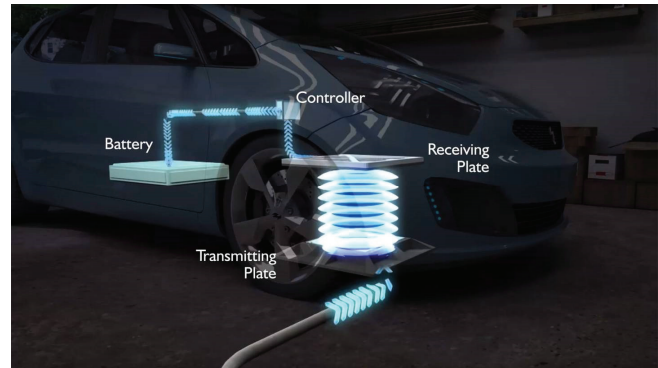
ORNL

| | | | | |
|---------|---------|----------|---------|----------|
| Eff_PFC | Eff_Inv | Eff_TRFR | Eff_C2C | Eff_Rect |
| 97.341 | 97.860 | 97.556 | 97.179 | 98.829 |



Eff_DCDC: 91.688

Total Eff: 89.250



Class E Topologies

