

## PLUGLESS™ Level 2 EV Charging System (3.3 kW) by Evatran Group Inc.

Results from Laboratory Testing as installed on a 2012 Chevy Volt

### Description / Specifications<sup>1</sup>

System Input Voltage operating Voltage	208 to 240 VAC
Circuit Breaker Rating	30 A
Nominal gap between coils	100 mm
Rated maximum power output	3300 watts
Parking Pad (Primary Coil system)	
Shape	Approximately Circular
Size	559 dia. x 470 long mm
Vehicle Adapter (Secondary Coil system)	
Shape	Rectangular
Size	762 long x 457 wide mm



### Measured System Parameters during nominal, steady state conditions<sup>2</sup>

Input Power	
Input Voltage	208 VAC
Input Current RMS	28 Amps RMS
Power Factor	0.60
Voltage Total Harmonic Distortion (THD)	3 %
Current Total Harmonic Distortion (THD)	134 %
Wireless Power Transfer Operation	
Operating Frequency (kHz)	18 - 20 kHz (variable)
DC Output Power (into On-Board Charge Module)	
Output Voltage	215 VDC
Output Current	13.8 Amps
Output Voltage Ripple Factor	0.76 %
Operating Temperature after 4.0 hours at 3.0 kW output	
Parking Pad: Max observed surface temperature	51 °C
Vehicle Adapter: Max observed surface temperature	48 °C



<sup>1</sup> Manufacturer's Specifications: [http://www.pluglesspower.com/wp/wp-content/uploads/2014/02/Plugless\\_Tech\\_Specs.pdf](http://www.pluglesspower.com/wp/wp-content/uploads/2014/02/Plugless_Tech_Specs.pdf)

<sup>2</sup> Test conducted at nominal conditions (3.0 kW output, 100mm coil gap, coils aligned) unless otherwise specified

## Measured System Efficiency

### Definition: Wireless Charging System Efficiency

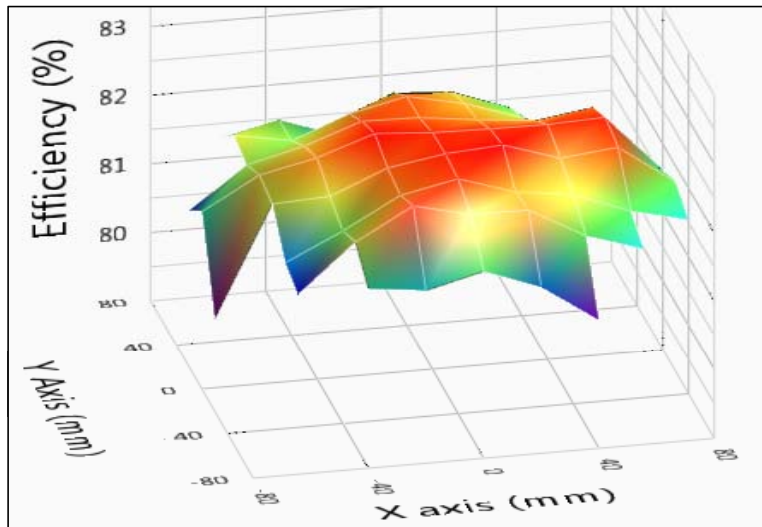
$$\text{System Efficiency} = \frac{\text{Energy out of PLUGLESS™ Vehicle Adapter into On-Board Charge Module}}{\text{Energy into PLUGLESS™ Control Panel from 208 VAC}}$$

### Chevy Volt charge event (from fully depleted to fully recharged)<sup>2</sup>

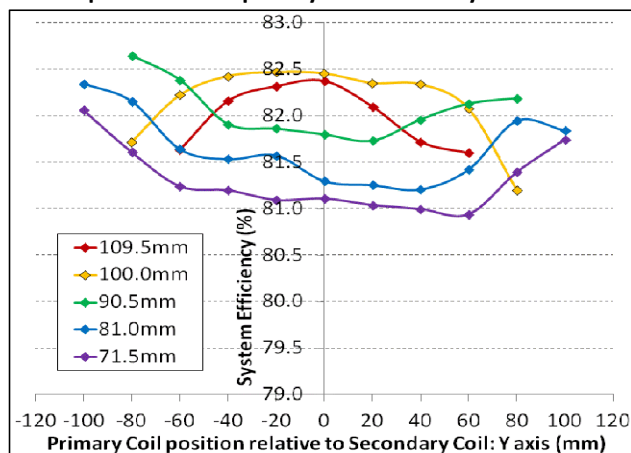
Input Energy from 208VAC	15.3 kWh
Output Energy to On-board Charge Module	12.6 kWh
PLUGLESS system charge efficiency	82.3 %
time for charge event	4.5 hours

### System Efficiency variation with coil misalignment<sup>2</sup>

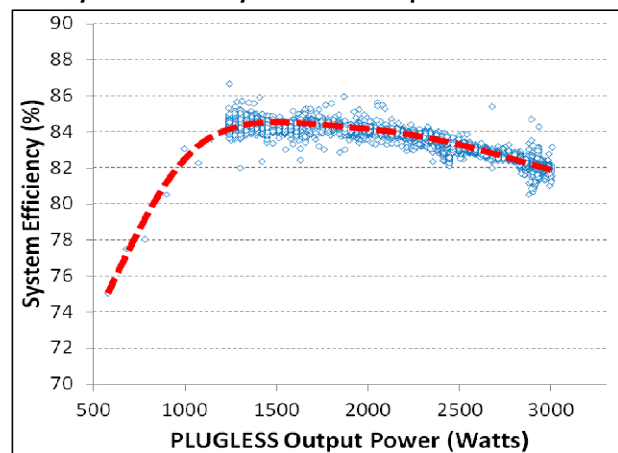
Maximum Efficiency (%)	82.5%	Primary Coil position relative to Secondary Coil (mm)
Efficiency when aligned(%)	82.5%	(20,-20)
		(0,0)



### Impact of Coil Gap on System Efficiency<sup>2</sup>

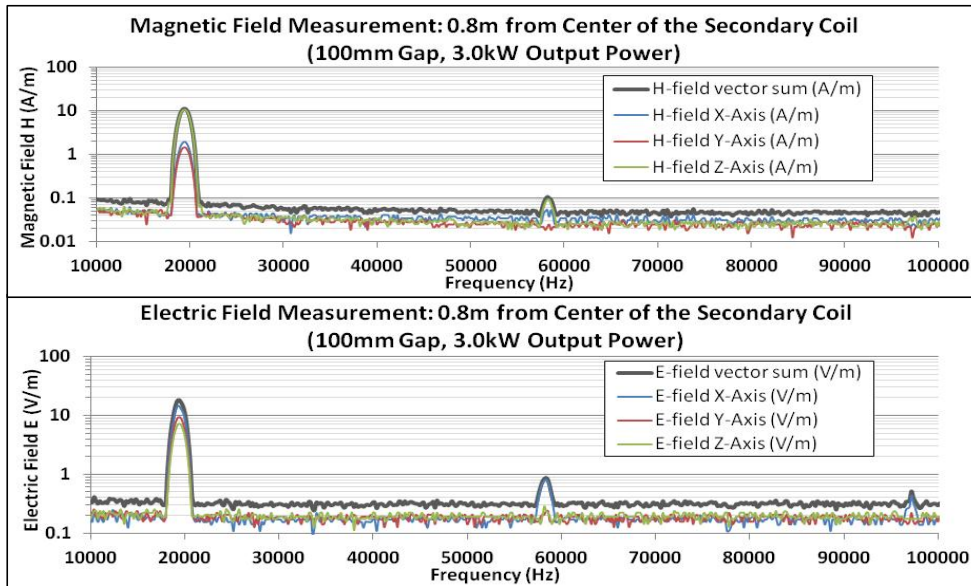


### System Efficiency at Various Output Power<sup>2</sup>

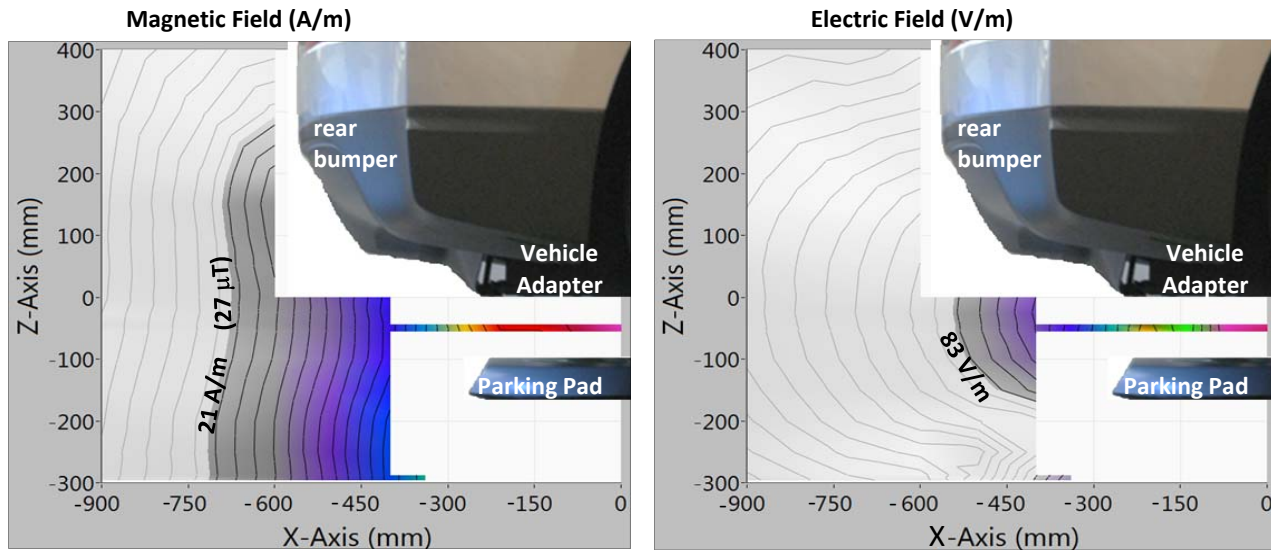


## Measured Magnetic and Electric Field

### Magnetic and Electric field Frequency Scan measurement (coils aligned)<sup>2,3</sup>



### Scan of Magnetic & Electric fields near vehicle rear bumper<sup>2</sup>



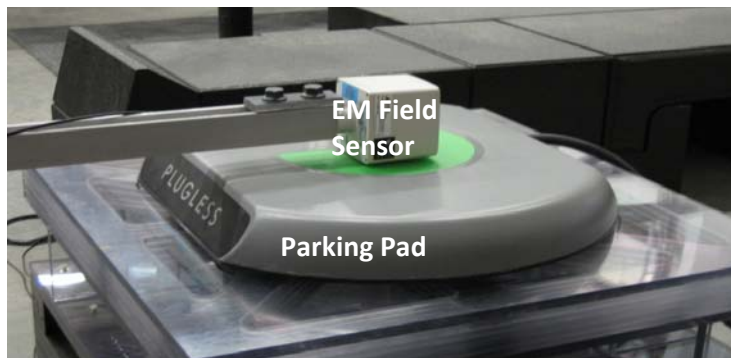
#### EM Field measurements<sup>2</sup>

Maximum H-field outside vehicle	1490 A/m (1872 $\mu$ T)	(0,-50)	centered between coils
Maximum E-field outside vehicle	5425 V/m	(0,-50)	centered between coils
H-field below rear bumper	33.6 A/m (42.2 $\mu$ T)	(-600,-50)	at rear bumper
E-field below rear bumper	57.3 V/m	(-600,-50)	at rear bumper
Maximum H-field inside vehicle	0.5 A/m (0.6 $\mu$ T)	(0,250)	inside trunk above charge system
Maximum E-field inside vehicle	0.8 V/m	(0,250)	inside trunk above charge system

#### EM Field meter position (X,Z)

<sup>3</sup> EM field measurement is centered between the gap (50mm below secondary coil) 0.8m from Secondary Coil Center along X-axis

## Vehicle Approaching Parking Location



### Vehicle far from parking pad (no vehicle nearby)

#### Input Power Measurements

Standby power (continuous)	11 Watts
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#### EM Field measurements

Maximum H-field	0.0 A/m (0.0 $\mu$ T)
Maximum E-field	0.0 V/m
Operating Frequency (kHz)	n/a kHz

#### EM Field measurement position

top surface center of parking pad
top surface center of parking pad

### Vehicle near parking pad; Initializing Charge Event (100mm gap; 300mm coil misalignment)

#### Input Power Measurements

Initialization input power (208 VAC)	171 Watts
Duration of initialization power	10 seconds

#### EM Field measurements

Maximum H-field	674 A/m (847 $\mu$ T)
Maximum E-field	1227 V/m
Operating Frequency (kHz)	19.5 kHz

#### EM Field measurement position

top surface center of parking pad
top surface center of parking pad