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**

- 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**

**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

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2 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)**

<table>
<thead>
<tr>
<th>Input Energy from 208VAC</th>
<th>15.3 kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Energy to On-board Charge Module</td>
<td>12.6 kWh</td>
</tr>
<tr>
<td>PLUGLESS system charge efficiency</td>
<td>82.3 %</td>
</tr>
<tr>
<td>time for charge event</td>
<td>4.5 hours</td>
</tr>
</tbody>
</table>

**System Efficiency variation with coil misalignment**

<table>
<thead>
<tr>
<th>Primary Coil position relative to Secondary Coil (mm)</th>
<th>Maximum Efficiency (%)</th>
<th>Efficiency when aligned (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(20, -20)</td>
<td>82.5%</td>
<td>82.5%</td>
</tr>
<tr>
<td>(0, 0)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Impact of Coil Gap on System Efficiency**

**System Efficiency at Various Output Power**
Measured Magnetic and Electric Field

Magnetic and Electric field Frequency Scan measurement (coils aligned)\(^2,3\)

Scan of Magnetic & Electric fields near vehicle rear bumper\(^2\)

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\(^2\) EM field measurement is centered between the gap (50mm below secondary coil) 0.8m from Secondary Coil Center along X-axis

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\(^3\) INL/MIS-14-33980

\(^\star\) 1/2/2015

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EM Field measurements\(^3\)

- Maximum H-field outside vehicle: 1490 A/m (1872 \(\mu\)T)
- Maximum E-field outside vehicle: 5425 V/m
- H-field below rear bumper: 33.6 A/m (42.2 \(\mu\)T)
- E-field below rear bumper: 57.3 V/m
- Maximum H-field inside vehicle: 0.5 A/m (0.6 \(\mu\)T)
- Maximum E-field inside vehicle: 0.8 V/m

EM Field meter position (X,Z)

- (0,50) centered between coils
- (-600,-50) at rear bumper
- (0,250) inside trunk above charge system
**Vehicle Approaching Parking Location**

![EM Field Sensor](EM Field Sensor.png)

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

**Input Power Measurements**
- Standby power (continuous): 11 Watts

**EM Field measurements**
- Maximum H-field: 0.0 A/m (0.0 µT)
- Maximum E-field: 0.0 V/m
- Operating Frequency (kHz): n/a kHz

**EM Field measurement position**
- 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 µT)
- Maximum E-field: 1227 V/m
- Operating Frequency (kHz): 19.5 kHz

**EM Field measurement position**
- top surface center of parking pad

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1/2/2015

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