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

Results from Full System Testing in a Laboratory environment

**Description / Specifications**

<table>
<thead>
<tr>
<th>Description</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Input Voltage operating Voltage</td>
<td>208 to 240 VAC</td>
</tr>
<tr>
<td>Circuit Breaker Rating</td>
<td>30 A</td>
</tr>
<tr>
<td>Nominal gap between coils</td>
<td>100 mm</td>
</tr>
<tr>
<td>Rated maximum power output</td>
<td>3300 watts</td>
</tr>
</tbody>
</table>

Parking Pad (Primary Coil system)

- **Shape**: Approximately Circular
- **Size**: 559 dia. x 470 long mm

Vehicle Adapter (Secondary Coil system)

- **Shape**: Rectangular
- **Size**: 464 long x 525 wide mm

**Measured System Parameters during Laboratory Testing**

**Input Power Measurements (at 3.3 kW output, 100mm gap)**

- **Input Voltage**: 208 VAC
- **Input Current RMS**: 28 Amps RMS
- **Power Factor**: 0.65
- **Voltage Total Harmonic Distortion (THD)**: 4%
- **Current Total Harmonic Distortion (THD)**: 112%

**Wireless Power Transfer Operation**

- **Operating Frequency (kHz)**: 19.5 kHz

**DC Output Measurements (at 3.3 kW output, 100mm gap)**

- **Output Voltage**: 214 VDC
- **Output Current**: 15.4 Amps
- **Voltage Ripple Factor**: 0.75%

**Operating Temperatures at 3.3 kW output**

- **Parking Pad**: Max observed surface temperature 51 °C
- **Vehicle Adapter**: Max observed surface temperature 47 °C

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2. Test Coordinates System Origin: Center of the Secondary Coil at the Bottom Surface of the Enclosure
Measured PLUGLESS™ System Efficiency

**Definition: Wireless Charging System Efficiency**

\[
\text{System Efficiency} = \frac{\text{Energy out of PLUGLESS™ Vehicle Adapter}}{\text{Energy into PLUGLESS™ Control Panel}}
\]

**Power Flow from Generation to Vehicle Operation**

- Electricity Generation
- Electricity Distribution
- Electricity Step Down Transformer
- Commercial / Residential Wiring & Receptacle
- PLUGLESS™ Control Panel / Power Electronics
- PLUGLESS™ Primary Coil
- PLUGLESS™ Secondary Coil
- PLUGLESS™ Vehicle Adapter / Power Electronics
- Vehicle On-Board Charge Module (OBCM)
- Vehicle Wiring / Accessory Loads
- Vehicle Traction Battery (ESS)
- Vehicle Propulsion

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**Efficiency Results (at 3.3 kW output with 100mm gap)**

- Maximum Efficiency (%) 88.8%
- Nominal Efficiency (%) 87.0%
- Minimum Efficiency (%) 86.1%

**Efficiency Results (at 3.3 kW output with 110mm gap)**

- Maximum Efficiency (%) 89.2%
- Nominal Efficiency (%) 88.1%
- Minimum Efficiency (%) 86.2%

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**Impact of Coil Gap (mm) on System Efficiency (3.3 kW Output Power)**

**Impact of Charge Power on System Efficiency (100 mm gap between coils)**

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Primary Coil position relative to Secondary Coil (mm)^2
(-90,-30)  (0,0)  (120,-60)

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**Measured PLUGLESS™ Magnetic and Electric Field**

Peak Magnetic and Electric fields (100mm gap, 3.3 kW output) for Primary Coil position relative to Secondary Coil

**Magnetic Field (H-field)**

- Maximum H-field (A/m): 21.9 (0,120)
- Nominal H-field (A/m): 12.9 (0,0)
- Maximum E-field (V/m): 35.2 (60,120)
- Nominal E-field (V/m): 22.1 (0,0)

**Electric Field (E-field)**

Primary Coil position relative to Secondary Coil (mm):
- (0,120)
- (0,0)
- (60,120)
- (0,0)

**Magnetic and Electric field Frequency Scan measurement (Primary Coil at 0,0 relative to Secondary Coil)**

**Magnetic Field Measurement: 0.8m from Center of the Secondary Coil (100mm Gap, 3.3kW Output Power)**

- H-field vector sum (A/m)
- H-field X-Axis (A/m)
- H-field Y-Axis (A/m)
- H-field Z-Axis (A/m)

**Electric Field Measurement: 0.8m from Center of the Secondary Coil (100mm Gap, 3.3kW Output Power)**

- E-field vector sum (V/m)
- E-field X-Axis (V/m)
- E-field Y-Axis (V/m)
- E-field Z-Axis (V/m)

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