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

Results from Full System Testing in a Laboratory environment

**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: 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

---

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**

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

**System Efficiency at 100mm gap for 3.3kW output**

- **Primary Coil position relative to Secondary Coil (mm)**
  - Maximum Efficiency (%): 88.8% (-90, -30)
  - Nominal Efficiency (%): 87.0% (0, 0)
  - Minimum Efficiency (%): 86.1% (120, -60)

**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)**

- Primary Coil position relative to Secondary Coil (mm): (-60, 30)
- Maximum Efficiency (%): 89.2%
- Nominal Efficiency (%): 88.1%
- Minimum Efficiency (%): 86.2%

**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)**

INL/MIS-13-29807
8/14/2013
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
- Nominal H-field (A/m) 12.9
- Maximum E-field (V/m) 35.2
- Nominal E-field (V/m) 22.1

**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)

**Notes:**

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