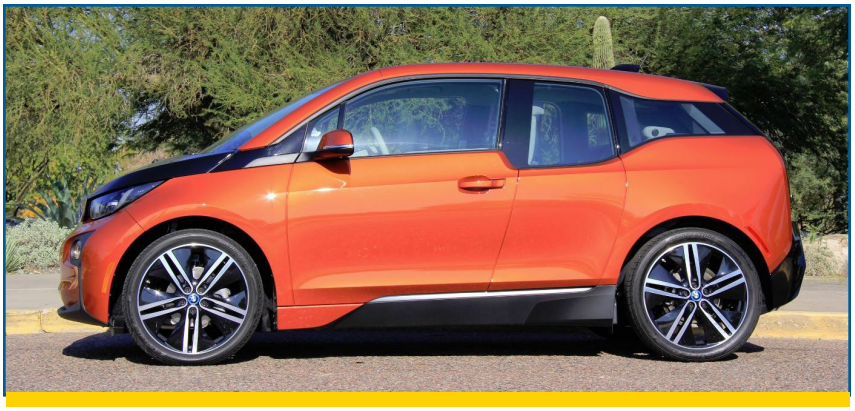
Steady State Vehicle Charging Fact Sheet: 2014 BMW i3



Description

The steady state charging behavior of a 2014 BMW i3 was tested at many different charge rates. Testing measured the efficiency and power quality of the vehicle. Vehicle charging is considered to be in steady state when the RMS current magnitude is not changing and the voltage source is close to nominal. Testing was done for 120 volt Level 1 charging, 208 volt Level 2 charging, and 240 volt Level 2 charging.

Key Insights from Testing

- The BMW i3 has the best power quality when charged at the max charge rate. The Level 2 efficiency is not strongly influenced by the charge rate.

Vehicle Specifications

Vehicle Type: Battery electric vehicle
Class: Mid-size
Battery: Lithium-ion
Rated Battery Capacity: 18.8 kWh
Charge Port: J1772 compatible
DC Fast Charge: Yes

Source Characteristics[2]

Nominal Frequency	60 Hz
Nominal Voltages	120 V / 208 V / 240 V
Max Deviation from Nominal Frequency	0.07%
Max Deviation from Nominal Voltage Magnitude	5.48%
Max Voltage Total Harmonic Distortion (THD)[3]	2.19%

Electrical Measurement Points[1]

- AC Input: EVSE Output
- DC Output: Powertrain Electrical Distribution Module high voltage and 12 volt output

Load Characteristics

Level 1 - 120 V Test

	Min Charge Rate	Max Charge Rate[7]
Charge Rate	0.66 kW	1.33 kW
Current[4]	5.6 A	11.6 A
Efficiency[5]	84.1%	89.6%
Power Factor[6]	0.99	1.00
Current THD[3]	14.0%	5.8%

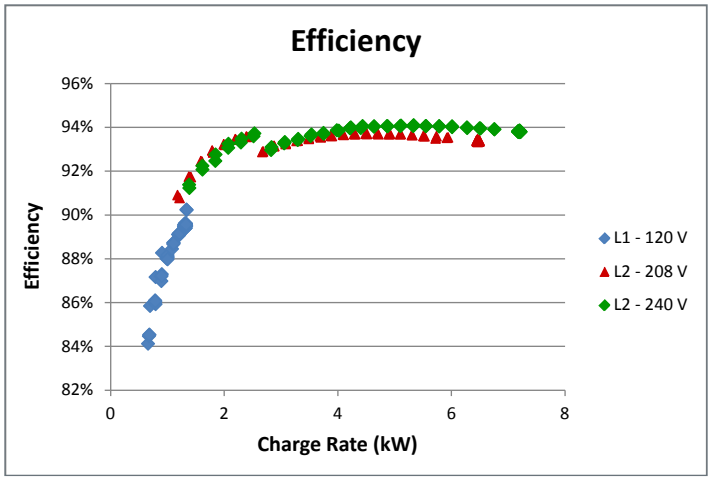
Level 2 - 208 V Test

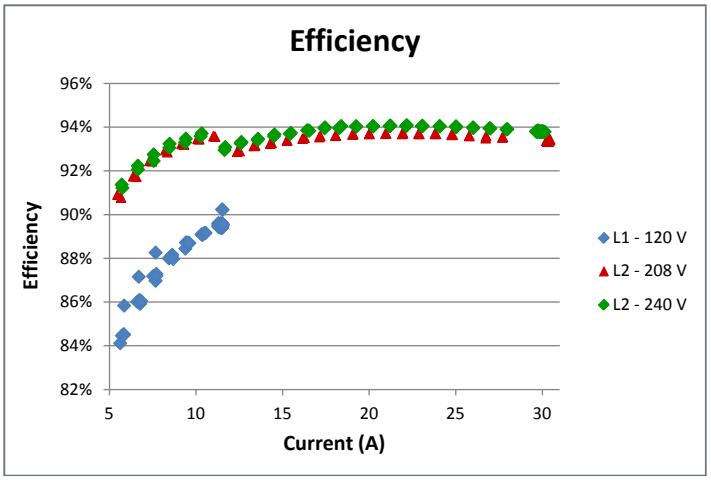
	Min Charge Rate	Max Charge Rate[8]
Charge Rate	1.18 kW	6.47 kW
Current[4]	5.5 A	30.5 A
Efficiency[5]	90.9%	93.4%
Power Factor[6]	0.98	1.00
Current THD[3]	18.5%	4.0%

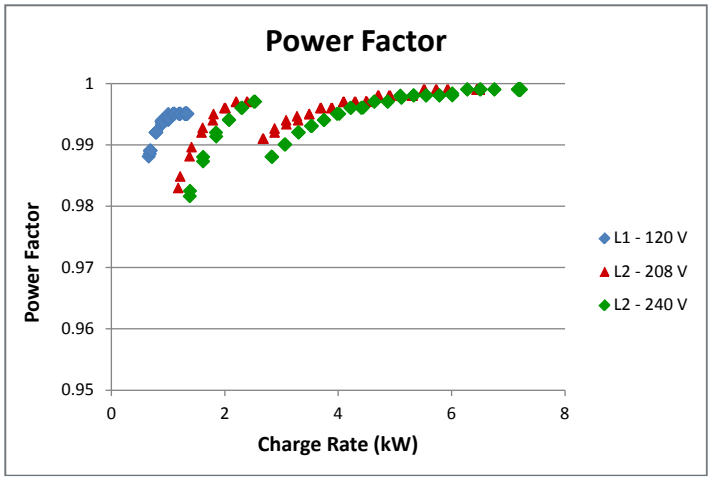
Level 2 - 240 V Test

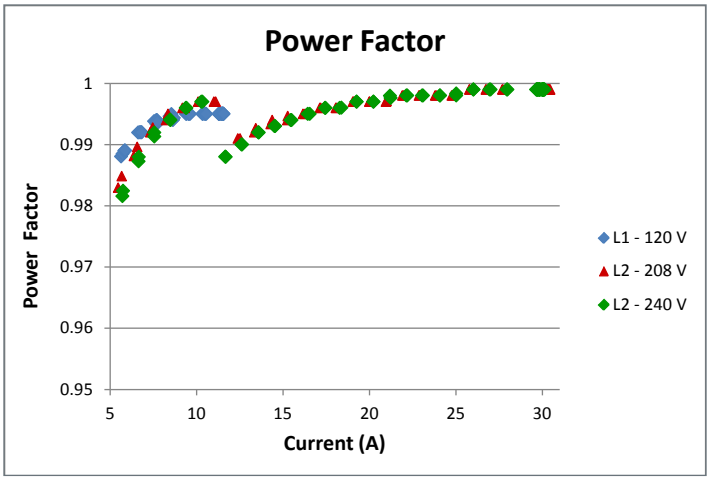
	Min Charge Rate	Max Charge Rate[8]
Charge Rate	1.38 kW	7.22 kW
Current[4]	5.7 A	30.1 A
Efficiency[5]	91.4%	93.8%
Power Factor[6]	0.98	1.00
Current THD[3]	17.6%	3.8%

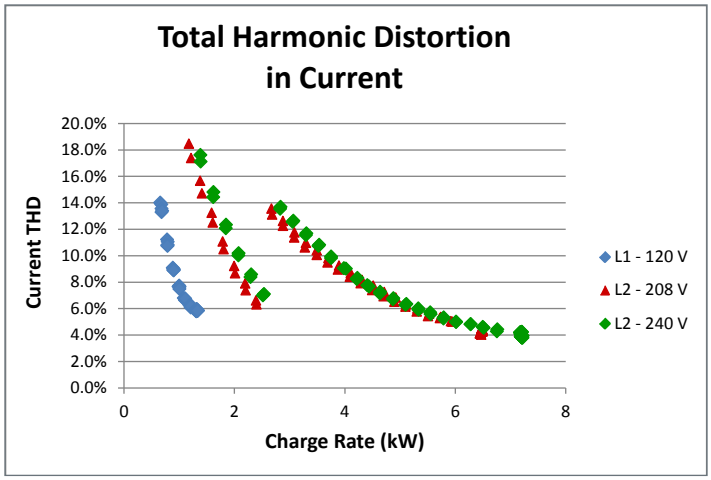
1. The DC output electrical measurement point was only used to calculate efficiency
2. The voltage source was close to nominal during the testing
3. See definition of total harmonic distortion on page 3
4. Current magnitudes are given in RMS values
5. See definition of efficiency on page 3
6. See definition of power factor on page 3
7. This is the max charge rate on a circuit with a continuous current rating of 12 amps
8. This is the max charge rate on a circuit with a continuous current rating of 32 amps

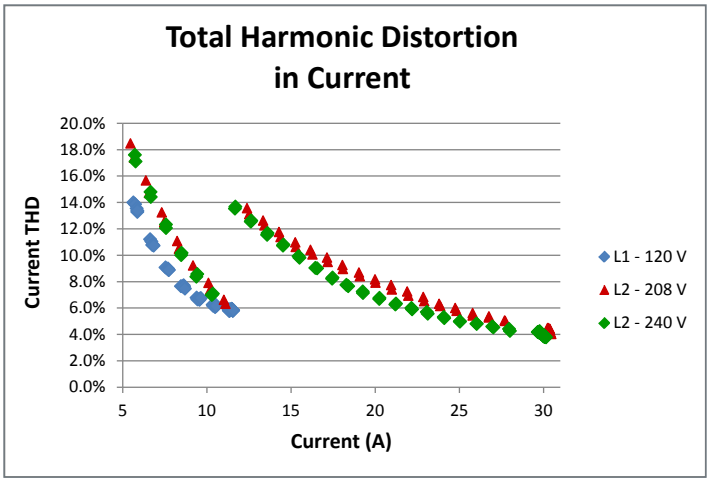












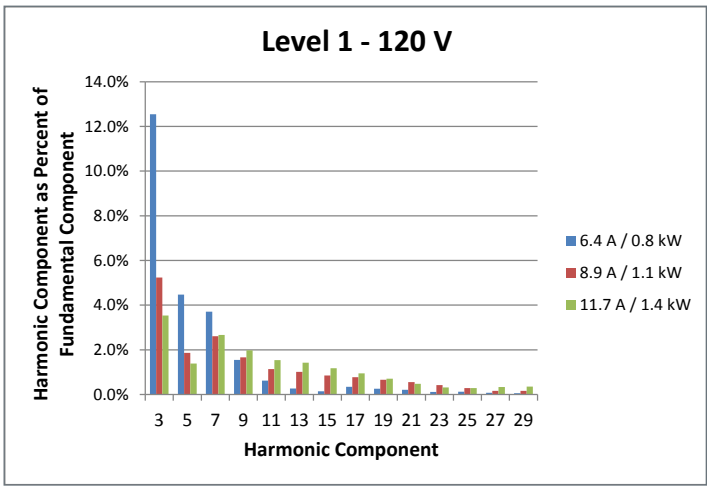
As the vehicle charge rate decreases, efficiency decreases, power factor decreases, and total harmonic distortion increases. For Level 2 charging, there is a step change in efficiency, power factor and total harmonic distortion at 13 amps or 3 kW..

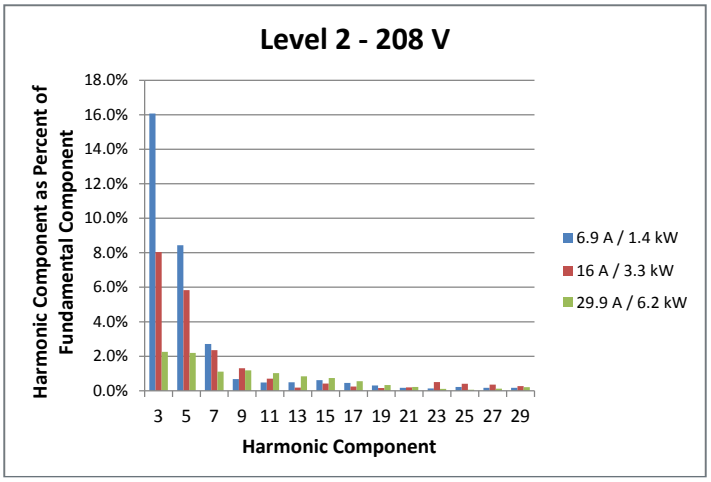
NOTES:

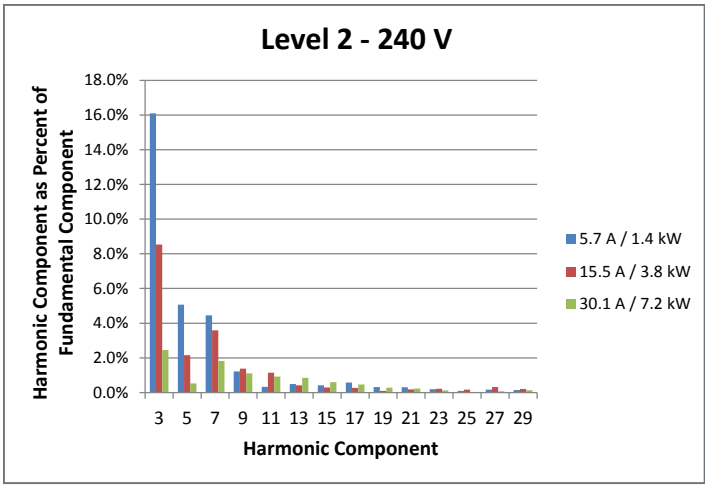
See the definitions for efficiency, power factor and total harmonic distortion on page 3

All current magnitudes are given as RMS values

L1 = Level 1 charging, L2 = Level 2 charging







The harmonic components for three different charge rates are displayed in the charts above for both the Level 1 and Level 2 tests. For each test, the minimum charge rate (blue), maximum charge rate (green), and a charge rate between the minimum and maximum (red) were selected. In all cases, the third harmonic is the dominant harmonic component.

Definitions

Efficiency - Efficiency is the useful power output divided by the total power input. In order to minimize the total amount of energy needed to complete a given task it is desirable for the efficiency to be as close to 100% as possible. The efficiency in this testing is the efficiency of the on-board charge module.

Power Factor- In the presence of a stiff voltage source, power factor is a measure of how much of the current is being utilized to perform work. Since the electrical infrastructure is limited in the amount of current it can deliver, power factor is a way to determine how efficiently the electrical infrastructure is being utilized. A power factor of 1 signifies that all of the current is delivering useful work, a power factor of 0.5 means that only half of the current delivering useful work. Ideally the power factor should be as close to 1 as possible.

Total Harmonic Distortion (THD) - In power systems, the voltage and current waveforms are both 60 Hz sinusoidal waveforms. The total harmonic distortion (THD) is a measure of the amount of distortion that is present in the sinusoidal wave form. Excessive amounts of THD in current wave forms can cause many problems in a power system such as overheating transformers, motors, and capacitors among other things. Ideally the THD should be as close to zero as possible.