Steady State Vehicle Charging Fact Sheet: 2015 Nissan Leaf

Description

The steady state charging behavior of a 2015 Nissan Leaf was tested at many different charge rates. Testing measured the efficiency and power quality of the vehicle charging. 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 both 120 volt Level 1 charging and 208 volt Level 2 charging.

Key Insights from Testing

- Nissan Leaf charging is most efficient and has the best power quality when charged at the maximum charge rate.
- When charging a 2015 Nissan Leaf, Level 2 charging should be used instead of Level 1 charging whenever possible. Level 2 charging is much more efficient than Level 1 charging.
- When reducing the charging of a group of 2015 Nissan Leafs, the charge rate can be reduced to a point with minimal impact to charging efficiency and power quality. If it is desirable to reduce the charge rate below this point, it is better to discontinue the charging of some vehicles to reach the charge reduction target than to continue to charge all vehicles at a lower charge rate where both efficiency and power quality will be negatively impacted.

Vehicle Specifications

Vehicle Type: Battery electric vehicle
Class: Mid-size
Battery: Lithium-ion
Rated Battery Capacity: 24 kWh
Charge Port: J1772 compatible
DC Fast Charge: Yes

Electrical Measurement Points[1]

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

Source Characteristics[2]

Nominal Frequency	60 Hz
Nominal Voltages	120 V / 208 V
Max Deviation from Nominal Frequency	0.13%
Max Deviation from Nominal Voltage Magnitude	2.03%
Max Voltage Total Harmonic Distortion (THD)[3]	1.67%

Load Characteristics

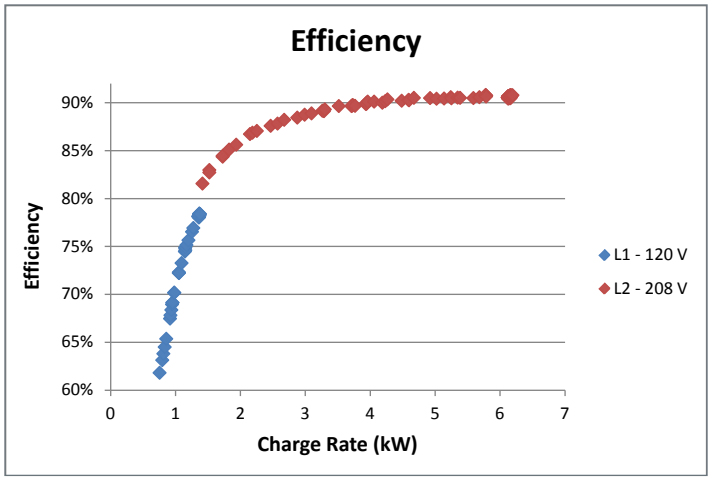
Level 1 - 120 V Test

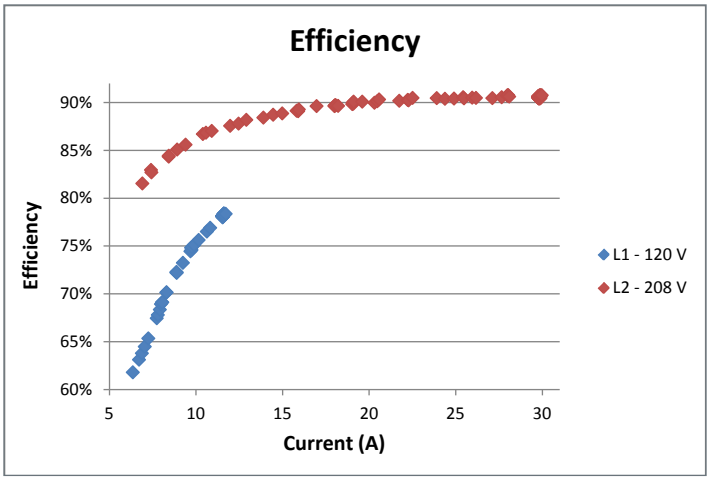
	Min Charge Rate	Max Charge Rate[7]
Charge Rate	0.75 kW	1.38 kW
Current[4]	6.4 A	11.7 A
Efficiency[5]	61.8%	78.4%
Power Factor[6]	0.99	1.00
Current THD[3]	13.8%	4.5%

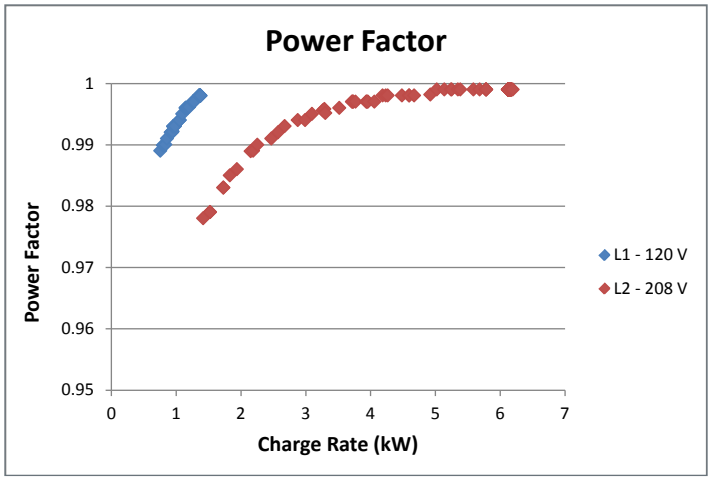
Level 2 - 208 V Test

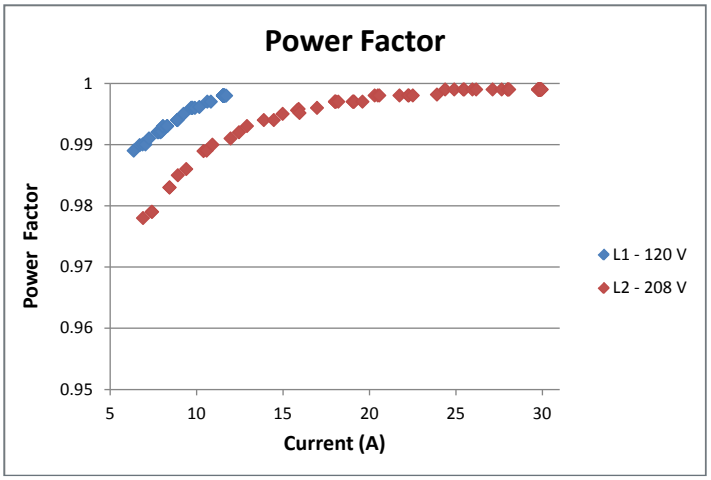
	Min Charge Rate	Max Charge Rate[8]
Charge Rate	1.41 kW	6.16 kW
Current[4]	6.9 A	29.9 A
Efficiency[5]	81.5%	90.5%
Power Factor[6]	0.98	1.00
Current THD[3]	18.9%	2.0%

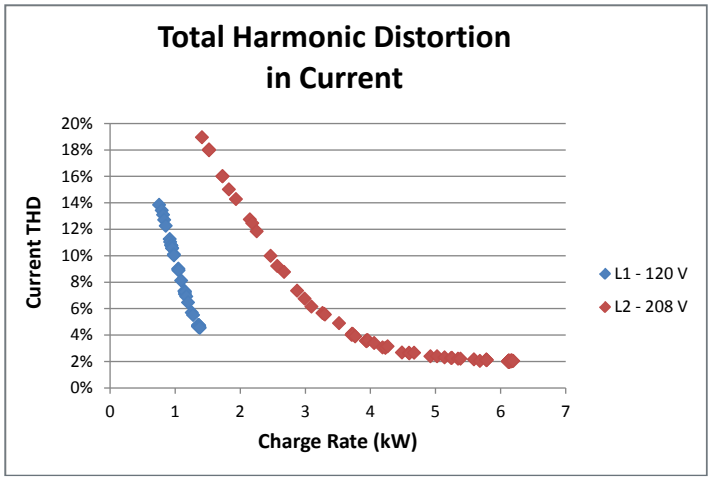
1. The DC output electrical measurement point was only used to calculate efficiency
2. The voltage source was close to nominal during the testing
3. See definition of total harmonic distortion on page 3
4. Current magnitudes are given in RMS values
5. See definition of efficiency on page 3
6. See definition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

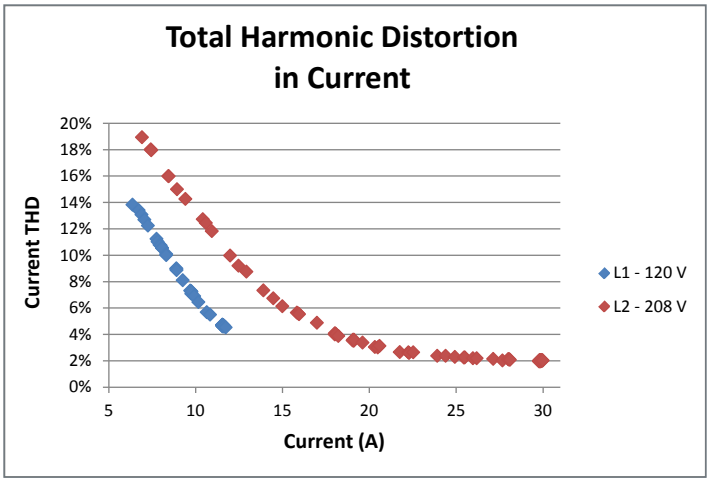












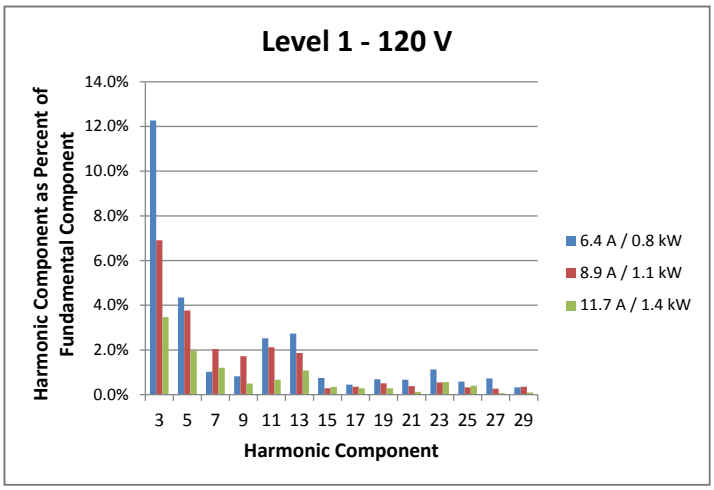
As the vehicle charge rate decreases, efficiency decreases, power factor decreases, and total harmonic distortion increases. The decrease in power factor is negligible, but the decrease in efficiency and increase in total harmonic distortion is not negligible and should be avoided when possible.

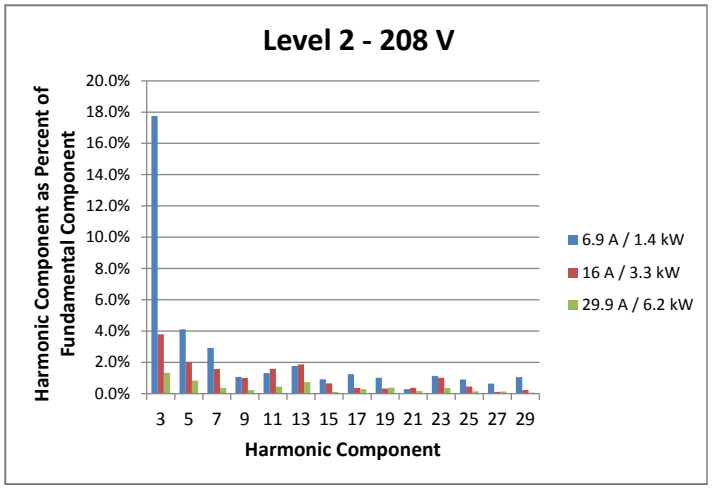
NOTES:

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.