ENERGY STAR® Program Requirements for Electric Vehicle Supply Equipment

Test Method for DC EVSE
Draft 1, Rev. Nov-2018

1 OVERVIEW

The following test method shall be used for determining DC EVSE compliance with requirements in the ENERGY STAR Eligibility Criteria for Electric Vehicle Supply Equipment.

2 APPLICABILITY

ENERGY STAR test requirements are dependent upon the feature set of the product under evaluation. The following guidelines shall be used to determine the applicability of each section of this document:

- The test procedures in Sections 6.1, 6.2, 6.3, and 6.4 shall be performed on all products.
- The test procedures in Section 6.5 shall be performed on products with network connectivity.

3 DEFINITIONS

Unless otherwise specified, all terms used in this document are consistent with the definitions in the ENERGY STAR Eligibility Criteria for Electric Vehicle Supply Equipment, Version 1.0. Presented below are new definitions specific to DC EVSE.

Note: The below section lists the definitions that EPA is considering using throughout the EVSE program, in addition to those terms already defined in the Version 1.0 EVSE specification. This section will eventually be moved to the Version 1.1 Specification/Eligibility Criteria document, but is included temporarily in this draft Test Method for ease of reference and to ensure that all aspects of the test method are defined appropriately.

A) Electric Vehicle Supply Equipment (EVSE): The conductors, including the ungrounded, grounded, and equipment grounding conductors, the electric vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, or apparatuses installed specifically for the purpose of delivering energy from the premises wiring to the electric vehicle. Charging cords with NEMA 5 15P and NEMA 5-20P attachment plugs are considered EVSEs. Excludes conductors, connectors, and fittings that are part of the vehicle.

   1) Level 1: A galvanically-connected EVSE with a single-phase input voltage nominally 120 volts ac and maximum output current less than or equal to 16 amperes ac.

   2) Level 2: A galvanically-connected EVSE with a single-phase input voltage range from 208 to 240 volts ac and maximum output current less than or equal to 80 amperes ac.

3) DC: A method that uses dedicated direct current (DC) electric vehicle/plug-in hybrid electric vehicle (EV/PHEV) supply equipment to provide energy from an appropriate off-board charger to the EV/PHEV in either private or public locations.[1]

4) Wireless / Inductive: A non-galvanically-connected EVSE.

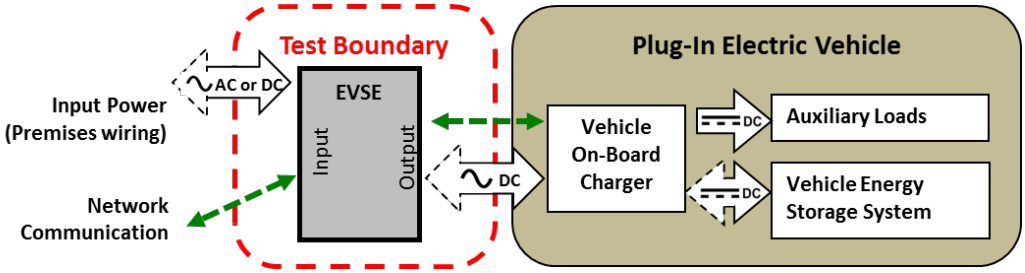

Figure 1: Schematic of Overall Plug-In Vehicle Charging System detailing DC-Output EVSE Test Boundary

B) Cabinet/Dispenser Product Configuration – A DC EVSE that has its components in two separate enclosures – one including the power conversion equipment (i.e., cabinet) and another enclosure that connects to the vehicle and has the user interface (i.e., dispenser).

C) All-in-One Product Configuration – A DC EVSE that has all of its components in one enclosure.

4 TEST SETUP

A) Test Setup and Instrumentation: Test setup shall be in accordance with the diagram in Figure 1a with additional requirements specified below. For EVSE that have a Cabinet/Dispenser product configuration, connect the two enclosures with the shortest cable possible.

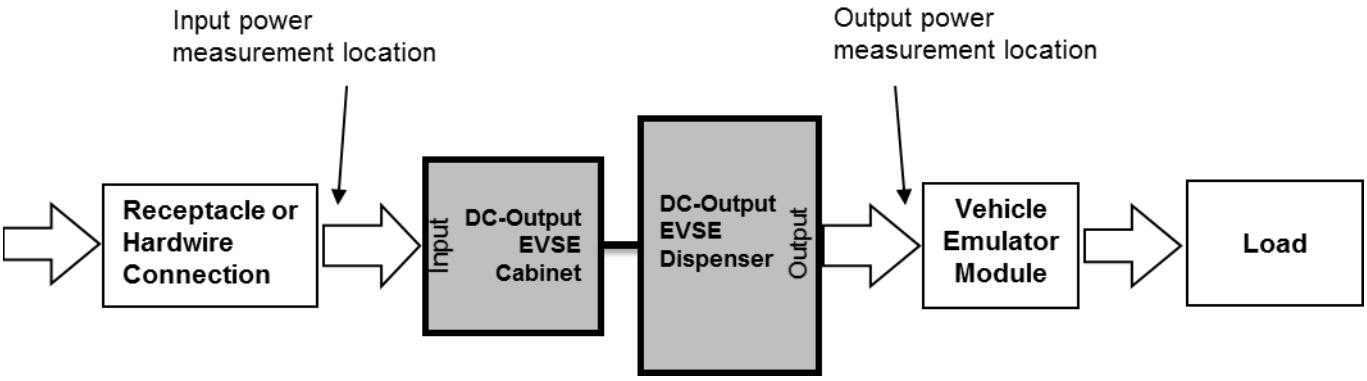

Figure 1a: Schematic of test setup connection for a cabinet/Dispenser Product Configuration. The two components are in one enclosure in an All-in-One Product Configuration

Note: EPA is proposing to test both Cabinet/Dispenser and All-in-One systems in a comparable way, with the DC link between cabinet and dispenser as short as possible.

[1] SAE International, Surface Vehicle Standard J1772, "SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler", Oct. 2017, Section 3.10.

B) AC Input Power: The UUT shall be operated at the first (highest) rated voltage and rated frequency combination specified in Table 1.

1) If the UUT requires two different voltages simultaneously (e.g., a lower voltage for accessory loads), then the requirements in this section shall apply to each voltage connection separately—i.e., first connect the high-voltage connection, then the low-voltage connection.
2) UUTs that are not compatible with any of the combinations listed in Table 1 shall be connected to the highest rated voltage and frequency combination appropriate for the intended market. The voltage and frequency used for the test shall be reported.
3) The voltage and frequency tolerance shall be as specified in Table 2.
4) Testing shall exclude any external transformer.
5) EVSE that support both 3-phase and single-phase input power shall be tested using 3-phase power (indicated with a Δ symbol for delta-connected three-phase, and Y for wye-connected three-phase).

Table 1: Low-voltage Input Supply Requirements

Voltage and Precedence	Frequency
1. 600Δ V ac	60 Hz
2. 600Y/346 V ac	60 Hz
3. 480Δ V ac	60 Hz
4. 480Y/277 V ac	60 Hz
5. 415Δ V ac	60 Hz
6. 415Y/240 V ac	60 Hz
7. 400Δ V ac	50 Hz
8. 400Y/230 V ac	50 Hz
9. 240 V AC	60 Hz
10. 208 V AC	60 Hz
11. 120 V AC	60 Hz

Table 2: Input Power Tolerances

Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency Tolerance
+/- 4.0 %	5.0 %	+/- 1.0 %

C) DC Input Power: Products shall be connected to the highest input voltage they support.

Note: EPA welcomes comments on the input power configuration for AC, which strives to ensure that products are tested at standardized input voltages to permit comparability of products with similar input voltage ranges. EPA welcomes feedback on similar standardized test conditions for DC-input products.

D) Input Power Measurements:

1) Cables: All power cables for the test shall be the default provided by the manufacturer

2) For EVSE equipped with input plug(s) and cord(s), the corresponding receptacle shall be used to provide power to the input plug(s) of the EVSE. If this is an EVSE with multiple inputs at the same voltage, the inputs shall be connected together in parallel, requiring only one power supply and one power meter. An Input Measurement Apparatus (IMA) shall be used with EVSE that are provided with input plug(s) and cord(s). The IMA enables input current and input voltage measurements of the EVSE without the need to modify the EVSE input cord(s).

a) Voltage Measurements shall be performed at the wiring terminals of the receptacle in the IMA providing power to the EVSE input plug.

b) Current Measurements shall be performed on the wiring of the IMA connected to receptacle terminals.

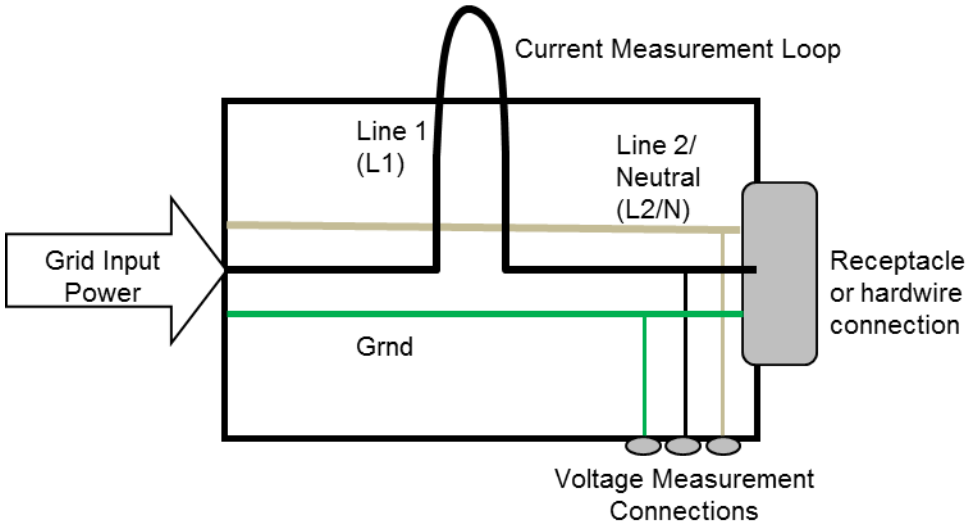

Figure 2: Schematic of Input Measurement Apparatus (IMA)[2]

3) For EVSE intended for hardwire connection, the UUT's input power shall then be connected to AC Input Power source with cables and optional connectors that are rated for the voltage and current levels that will be encountered during testing.

a) Voltage Measurements shall be performed at the hardwire connection location at the input terminal of the EVSE.

b) Current Measurements shall be performed on the wiring to the EVSE hardwire connection.

[2] In a four-conductor system, the conductor labeled L2/N will actually be two separate conductors: L2 and N.

E) Ambient Temperature: Ambient temperature shall be set at the conditions specified in Table 2 for different portions of the test. Tests that appear in multiple temperature rows shall be repeated in each of the specified temperature ranges.

Table 2: Ambient Test Temperatures for DC EVSE

Type of Climate	Representative Temperature	Test
Cold	20° F or –7° C (± 5° F, ± 2.5° C)	No Vehicle, Partial On, Idle, Operation
Temperate	68° F or 20° C (± 5° F, ± 2.5° C)	No Vehicle, Partial On, Idle, Operation
Hot	104° F or 40° C (± 5° F, ± 2.5° C)	No Vehicle, Partial On, Idle, Operation

Note: EPA is requesting feedback from stakeholders on the proposed ambient test condition temperatures. Specifically, if it is necessary to require operation mode testing at all three ambient temperature conditions in Table 2 based on what extent power consumption will be impacted by ambient temperature when the EVSE is operating at maximum current.

F) Relative Humidity: Relative humidity shall remain between 10% and 80% for the duration of the test.

G) Test Load: A DC Test Load shall be used for testing DC Output EVSE. The DC load shall be combined with a Vehicle Emulator Module (VEM) that can communicate via the protocol defined for the connector type intended to ship with the product (e.g., for Combined Charging System, or CCS, the VEM shall communicate via SAE J1772 Appendix F and G).

1) Load: The load shall possess the following capabilities

a) Sink current up to the rated current of the UUT;

b) Voltage range within the level of the UUT; and

c) Controllable current levels capable of achieving power levels detailed in Table 3.

H) Power Meter: Power meters shall possess the following attributes:

1) Number of Channels: The number of channels sufficient to measure all input current into the device shall be set up.

2) Crest Factor:

a) An available current crest factor of 3 or more at its rated range value; and

b) Lower bound on the current range of 10 mA or less.

3) Minimum Frequency Response: 3.0 kHz

4) Minimum Resolution:

a) 0.01 W for measurement values less than 10 W;

b) 0.1 W for measurement values from 10 W to 100 W; and

c) 1.0 W for measurement values greater than 100 W.

5) Accuracy: +/- 0.1% of reading PLUS +/- 0.1% of full scale

6) Measurements and Calculations:

a) Cable Length (ft.);

b) Cable Gauge (AWG);

c) Power Factor (PF);

d) Apparent Power (S);

e) Voltage (RMS);

f) Current (RMS);

g) Average Power (W); and

h) Frequency (Hz).

B) Illuminance Meter Accuracy:

1) All illuminance meters shall be accurate to ± 2% (± 2 digits) of the digitally displayed value.

Note: The overall accuracy of a meter is found by taking (±) the absolute sum of 2% of the measurement and a 2-digit tolerance of the displayed value least significant digit. For example, if a meter displays “200.0” when measuring an illuminance of 200 lx, 2% of 200 lx is 4.0 lx. The least significant digit is 0.1 lx. “Two digits” implies 0.2 lx. Thus, the displayed value would be 200 ± 4.2 lx (4 lx + 0.2 lx). The accuracy is specific to the illuminance meter and shall not be considered as tolerance during actual light measurements. Light measurements shall be within the tolerance specified in 5.1.E)3).

5 TEST CONDUCT

5.1 Guidance for Implementation of the EVSE Test Procedure

A) As-shipped Condition: Unless specified otherwise, the model unit shall be tested in its default configuration as-shipped.

1) The UUT shall be installed per the manufacturer’s installation instructions. If no manufacturer instructions are provided, the UUT shall be tested on a thermally non-conductive surface (e.g., wood or rubber).

B) UUT Configuration and Control:

1) Network Connection Capabilities:

a) Verify the UUT has network connection capabilities:

i. Network connections should be listed in the user manual or installation instructions.

ii. If no connections are specified, verify that the EVSE does not have network capabilities by checking for the absence of physical connections or the absence of network settings in the menu.

2) Peripherals and Network Connections:

b) Any peripherals shipped with the UUT shall be connected to their respective ports per manufacturer instructions. No other devices or accessories shall be connected to any remaining open ports.

c) If the UUT has network connection capabilities, the capabilities shall be activated using any standard or optional hardware provided by the manufacturer, and the UUT shall be connected to a live physical network (including wireless Radio Frequency (RF)).

a. The network shall support the highest and lowest data speeds of the UUT’s network function.

b. An active connection is defined as a live physical connection over the physical layer of the networking protocol.

c. If the UUT is equipped with multiple network capabilities, only one connection shall be made in the following order of preference:

i. Wi-Fi (Institution of Electrical and Electronics Engineers - IEEE 802.11- 2007[3]);

ii. Ethernet (IEEE 802.3). If the UUT supports Energy Efficient Ethernet Defined in Clause 78 of IEEE 802.3 (originally specified in IEEE 802.3az)[4], then it shall be connected to a device that also supports IEEE 802.3az;

iii. Cellular modem; or

iv. Other.

d) The tester shall configure the address layer of the protocol, taking note of the following:

i. Internet Protocol (IP) v6 has Neighbor Discovery and will generally configure a limited, non-routable connection automatically.

ii. IP can be configured manually or using Dynamic Host Configuration Protocol (DHCP) with an address in the 192.168.1.x Network Address Translation (NAT) address space if the UUT does not behave normally when autoIP is used. The network shall be configured to support the NAT address space and/or autoIP.

e) The UUT shall maintain this live connection to the network for the duration of testing, disregarding any brief lapses (e.g., when transitioning between link speeds).

f) Ensure there is a connection to the Wide Area Network if required in the manufacturer's instructions.

g) If the UUT needs to install any software updates, wait until these updates have occurred; otherwise, if it will operate without updates, skip these updates.

h) In the case of a UUT that has no data/network capabilities, the UUT shall be tested as-shipped.

C) Luminance Testing for Products with a Display: Luminance testing shall be performed for all products at 100% of screen brightness possible as measured in Section 6.2 of the ENERGY STAR Test Method for Determining Display Energy (Rev. Sep-2015).

1) If the UUT cannot display the three-bar pattern specified in IEC 62087:2011, Section 11.5.5, through an external port or network connection, the UUT shall be tested using the default image that appears as-shipped.

D) Display Brightness for Products without Automatic Brightness Control (ABC) Enabled By Default: If the UUT has a display the brightness of which is controllable by the user and does not have ABC enabled as-shipped:

1) The display shall be adjusted to 65% of the maximum brightness available on the display during all testing, or a setting available that is closest to 65%, to within the tolerance of the adjustments available on the EVSE (e.g., if the EVSE provides settings resulting in 50% and 75% of maximum brightness, choose the 75% setting).

2) Following this initial set-up, power testing shall be conducted with the default image that appears as-shipped.

E) Room Illuminance Conditions for Products with ABC Enabled by Default: All products with ABC enabled by default shall be tested in two illuminance conditions—light and dark—to simulate daytime and nighttime conditions:

[3] IEEE 802 – Telecommunications and information exchange between systems – Local and metropolitan area networks – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

[4] IEEE 802 – Telecommunications and information exchange between systems – Local and metropolitan area networks – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

1) Lamp Type:

a) Standard spectrum halogen flood reflector lamp. The lamp shall not meet the definition of "Modified spectrum" as defined in 10 CFR 430.2 - Definitions[5].

b) Rated Brightness: 980 ± 5% lumens.

2) Light Source Alignment For Testing Products with ABC Enabled By Default:

a) There shall be no obstructions between the lamp and the UUT's Automatic Brightness Control (ABC) sensor (e.g., diffusing media, frosted lamp covers, etc.).

b) The center of the lamp shall be placed at a distance of 5 feet from the center of the ABC sensor.

c) The center of the lamp shall be aligned at a horizontal angle of 0° with respect to the center of the UUT's ABC sensor.

d) The center of the lamp shall be aligned at a height equal to the center of the UUT's ABC sensor with respect to the floor (i.e., the light source shall be placed at a vertical angle of 0° with respect to the center of the UUT's ABC sensor).

e) No test room surface (i.e., floor, ceiling, and wall) shall be within 2 feet of the center of the UUT's ABC Sensor.

f) Illuminance values shall be obtained by varying the input voltage of the lamp.

g) Figure 4 and Figure 5 provide more information on UUT and light source alignment.

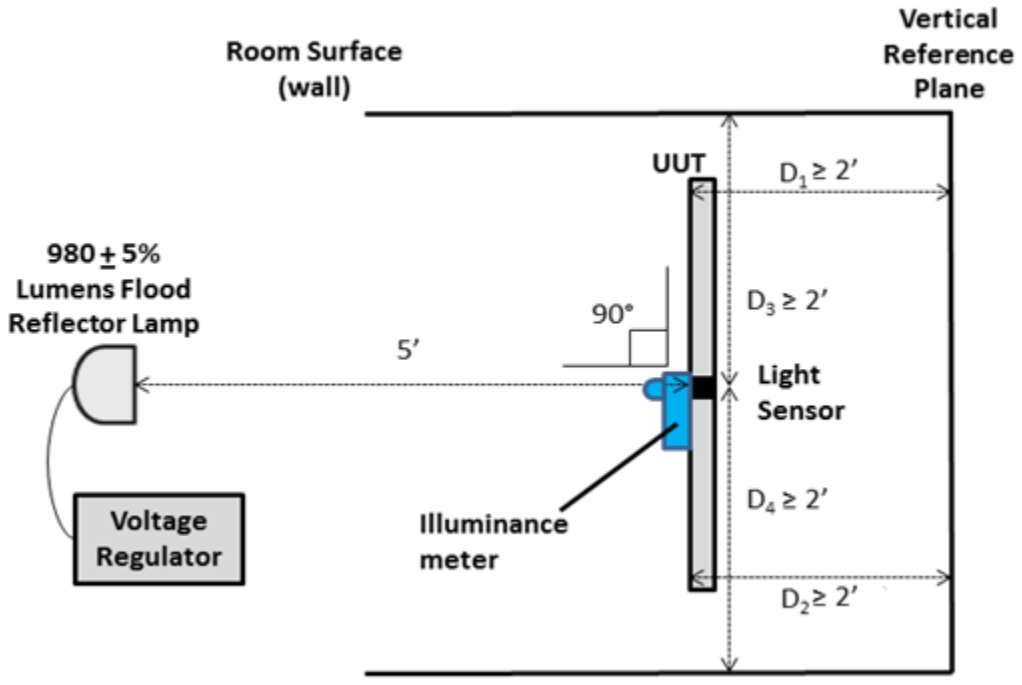

Figure 4: Test Setup - Top View

Notes:

- $D_1 = D_2$ with respect to vertical reference plane

[5] http://www.gpo.gov/fdsys/pkg/CFR-2011-title10-vol3/pdf/CFR-2011-title10-vol3-sec430-2.pdf

- D_1 and D_2 indicate that the corners of the face of the UUT shall be at least 2 feet from the vertical reference plane
- D_3 and D_4 indicate that the center of the light sensor shall be at least 2 feet from the room walls

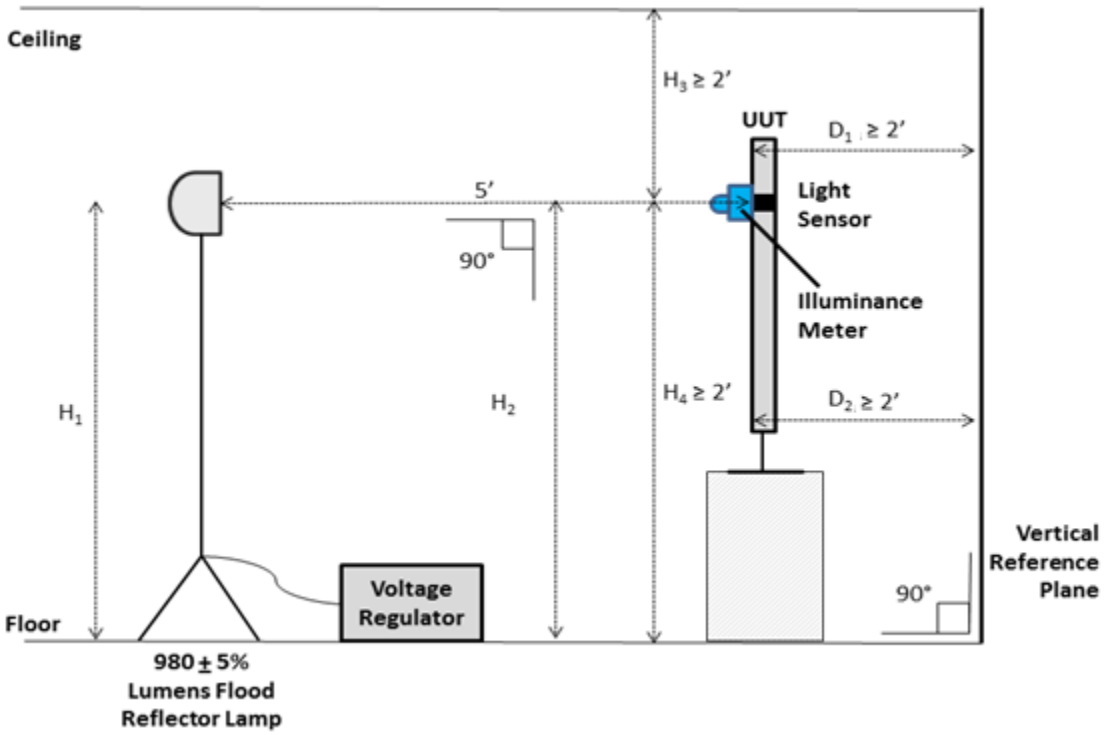

Figure 5: Test Setup - Side View

Notes:

- $D_1 = D_2$ with respect to vertical reference plane
- D_1 and D_2 indicate that the corners of the face of the UUT shall be at least 2 feet from the vertical reference plane
- $H_1 = H_2$ with respect to horizontal reference plane (e.g. floor)
- H_3 and H_4 indicate that the center of the light sensor must be at least 2 feet from the floor and 2 feet from the ceiling
- Illuminance meter shall be removed for power measurements, after target illuminance achieved

3) Setting Illuminance Conditions:

a) Power shall be disconnected from the UUT.

b) An illuminance meter shall be placed vertically, parallel to the UUT standing upright, such that the meter's sensor faces away from the UUT horizontally.

c) The illuminance meter shall be placed immediately in front of the UUT's automatic brightness control (ABC) sensor.

d) The lamp shall be adjusted such that the illuminance meter reads 300 ± 9.0 lux.

e) The illuminance meter shall be removed after target illuminance has been achieved and all testing conducted under the specified illuminance conditions.

f) After all testing has been completed under the high-illuminance conditions, the above steps a) through e) shall be repeated with a target illuminance equal to 10 ± 1.0 lux.

Note: In the Version 1.0 Specification for AC EVSE, EPA required that products capable of automatic brightness control (ABC) be tested at two different illuminance conditions – light and dark – to determine the average power consumption of an EVSE with this feature. EPA believed that this was important for Version 1.0 because the energy efficiency requirements were only set for standby modes, where the power of a display may have a significant impact on overall power draw.

While the DC EVSE are expected to draw more power in standby than AC EVSE, they are also expected to have more components that can be controlled by ABC (e.g., larger displays, indicator lights, or ambient lighting). For example, a DC EVSE that draws 100 W in standby may have ambient lighting that draws 10 W and turns on at dark. Keeping the above ABC test requirements would ensure that this product is tested in a repeatable manner (i.e., the lighting conditions in the lab do not exceed the 2% uncertainty requirements specified in Section H), below) and it receives credit for saving energy during the day.

EPA would appreciate stakeholder feedback on this proposal.

F) Test Conditions for Products with an Occupancy Sensor Enabled by Default:

1) Products with an Occupancy Sensor shall be positioned facing away from any testers, or have the sensor covered or otherwise disabled to be in an open position for the duration of the test.

G) Luminance Meters:

1) Luminance measurement shall be performed using either
   a) A contact meter; or
   b) A non-contact meter.
2) All luminance and illuminance meters shall be accurate to ± 2% (± 2 digits) of the digitally displayed value.
3) Non-contact luminance meters shall have an acceptance angle of 3 degrees or less.

The overall accuracy of a meter is found by taking (±) the absolute sum of 2% of the measurement and a 2-digit tolerance of the displayed value least significant digit. For example, if an illuminance meter displays “200.0” when measuring a screen brightness of 200 cd/m^2, 2% of 200 cd/m^2 is 4.0 cd/m^2. The least significant digit is 0.1 cd/m^2. “Two digits” implies 0.2 cd/m^2. Thus, the displayed value would be 200 ± 4.2 cd/m^2 (4 cd/m^2 + 0.2 cd/m^2). The accuracy is specific to the illuminance meter and shall not be considered as tolerance during actual light measurements.

H) Measurement Accuracy for All Products:

1) Power measurements with a value greater than or equal to 0.5 W shall be made with an uncertainty of less than or equal to 2% at the 95% confidence level.

2) Power measurements with a value less than 0.5 W shall be made with an uncertainty of less than or equal to 0.01 W at the 95% confidence level.

3) All ambient light values (measured lux) shall be measured at the location of the ABC sensor on the UUT with light entering directly into the sensor and showing the default image that appears as-shipped.

4) Ambient light values shall be measured within the following tolerances:

a) At 10 lux, ambient lighting shall be within ± 1.0 lux; and

b) At 300 lux, ambient lighting shall be within ± 9.0 lux.

6 TEST PROCEDURES FOR ALL PRODUCTS

6.1 UUT Preparation

A) Prior to the start of testing, the UUT shall be initialized as follows:

1) Set up the UUT per the instructions in the supplied product manual.

2) Verify the VEM output is connected to the DC load

3) Connect the power meter to as described in Section 4.D) .

4) Determine the maximum available output power of the UUT by using the VEM to communicate with the UUT via the protocol defined for the connector type intended to ship with the product (e.g., for CCS connector type, the VEM shall communicate via the SAE J1772 pilot signal).

5) Provide input power to the EVSE input connection(s).

6) Power on the UUT and perform initial system configuration, as applicable.

7) Ensure the UUT settings are in their as-shipped configuration, unless otherwise specified in this Test Method.

8) Report the test room ambient temperature, relative humidity, and the presence of ABC and occupancy sensors.

B) For EVSE with an integral battery bank, the battery shall be disabled, if possible. If it cannot be disabled, the internal battery shall be at full charge prior to testing.

Note: EPA is proposing that for EVSE with an internal battery bank, the battery be disabled during testing, or if that is not possible, to charge the battery to full capacity before charging. EPA believes this to be the best option to easily compare products with or without an internal battery with the least test burden, by not needing to account for the efficiency of the battery. However, if the efficiency of the battery may significantly impact the efficiency of a DC EVSE, EPA may consider requiring testing with the battery disabled and with it enabled to determine the efficiency impacts of the battery. EPA is seeking feedback on these options for DC EVSE with an internal battery bank.

C) If the EVSE has multiple connector types, choose the one that has the highest power or current rating for the following tests.

Note: For simplicity, for multiple-output EVSE, EPA is only proposing to test a single, highest-current output. In addition, EPA is proposing the same measurement for both single-output and multiple-output EVSE, returning the total power. This is in contrast to the AC test method, where all the outputs were tested and the measured power was divided by the number of outputs. EPA expects this to simplify the test and reduce the burden, but welcomes feedback on the change.

If tests reveal that multiple-output DC EVSE draw more power while providing additional functionality, this can be accounted for in the ENERGY STAR eligibility criteria through allowances that scale with the number of outputs.

Furthermore, the test does not specify how to test modular EVSE, the output power of which can be adjusted by adding/removing modules. Each combination of modules could be tested under this test method, potentially leading to different results. How to evaluate those results, or how to select more limited combination(s) of modules for test that can represent all the combinations can be specified later in the ENERGY STAR eligibility criteria (e.g., the highest-energy using combination, the typical combination, etc.). EPA welcomes stakeholder input on the testing of modular products.

6.2 No Vehicle Mode (E.g., SAE J1772 State A) Testing

A) No Vehicle Mode testing shall be conducted for all products.

B) Conduct the UUT preparation procedure in Section 6.1

C) Verify the UUT output connector is unplugged from VEM.

D) Measure and record UUT input power: $P = \frac{1}{T}\int_0^T v_{in}(t) \times i_{\text{in}}(t)dt$

E) Power shall be measured according to IEC 62301 Ed 2.0-2011; with the additional guidance in Section 5 of this document.

6.3 Partial On Mode (E.g., SAE J1772 State B) and Idle Mode (E.g., SAE J1772 State C) Testing

A) Conduct the UUT preparation procedure in Section 6.1

B) Ensure any demand-response functionality or timer is disabled.

1) If demand-response functionality or timer cannot be disabled and a demand-response or timer function occurs during a test, the results from the test shall be replaced with results from a substitute test.

C) Conduct the following procedure to measure the UUT power consumption:

1) State C[6]: Plug in the UUT output connection to vehicle inlet on a VEM and enter State C. Measure and record:

a) UUT input power; $P = \frac{1}{T}\int_0^T v_{in}(t) \times i_{in}(t)dt$

b) UUT output current I_{out} (to verify zero output current).

2) State B[7]: Plug in the UUT output connection to vehicle inlet on the VEM. Wait 2 minutes and then measure and record UUT input power: $P = \frac{1}{T}\int_0^T v_{in}(t) \times i_{in}(t)dt$

D) Power shall be measured according to IEC 62301 Ed 2.0-2011; with the additional guidance in Section 5 of this document.

6.4 Operation Mode (State C) Testing[8]

A) Ensure any demand-response functionality or timer is disabled.

[6] This state name refers to SAE J1172. If using a SAE J1772-compliant VEM, switch it to State C by closing switch S2. If testing using another protocol, enter the sate which represents a vehicle connected and ready to accept current.

[7] This state name refers to SAE J1172. If using a SAE J1772-compliant VEM, switch it to State B by opening switch S2. If testing using another protocol, enter the sate which represents a vehicle connected but not ready to accept current.

[8] This state is similar to Charging and Maintenance Modes in SAE J2894-2; however, there may be some discrepancies due to network configuration, the lack of a connected battery, and discrete number of power values tested.

1) If demand-response functionality or timer cannot be disabled and a demand-response or timer function occurs during a test, the results from the test shall be replaced with results from a substitute test.

B) Determine the UUT available current.

1) Backfeeding the source may be used in place of a test load during testing of EVSE systems, provided that an output power factor greater than 0.99 is maintained at all times.

2) Conduct the UUT preparation procedure in Section 6.1.

3) For multiple-output EVSE, the available current shall be the maximum current that can be provided by the unit when a single output is being used (i.e., no derating/current sharing). The unit shall be configured to provide this maximum current.

4) State C[9]: Plug in the UUT output connection to vehicle inlet on VEM.

C) Warm-up

1) Ensure the unit is kept at ambient temperature for 30 minutes prior to the test.

2) Engage the load and draw 10 kW as specified in Table 3 for 5 minutes or more.

3) Only one warm-up period of 5 minutes is required for each unit under test at the beginning of the test procedure.

Note: EPA expects the majority of DC EVSE to use active cooling, with more cooling (and additional losses due to cooling) expected at higher loads. Moreover, EPA expects there to be a "power overhang"; i.e., the EVSE will not immediately disable or turn down the cooling after the load is decreased. Therefore, to prevent the cooling losses at higher load from being reflected in the test results at lower loads (where they could have a bigger impact on efficiency) EPA proposes to reverse the test order relative to AC EVSE and test from lower to higher load. EPA welcomes feedback on this proposal and how to best ensure that a relatively short operation mode test is nonetheless representative of typical operation.

D) Measurement

1) After the 5-minute warm-up period, the technician shall monitor input current for a period of 5 minutes to assess the stability of the unit under test.

a) If the input current level does not drift by more than 1 percent from the maximum value observed over the 5-minute period, the unit under test can be considered stable and measurements can be recorded at the end of the 5-minute period.

b) If input current is not stable over a 5-minute period, the technician shall follow the guidelines established by IEC Standard 62301 for measuring average power or accumulated energy over time for both input and output.

2) The following measurements and calculated values shall be recorded after the 5-minute stabilization period:

a) RMS input current;

b) RMS input voltage;

c) Power Factor (PF)

d) RMS output current for each output;

[9] This state name refers to SAE J1172. If using a SAE J1772-compliant VEM, switch it to State C by closing switch S2. If testing using another protocol, enter the sate which represents a vehicle connected and ready to accept current.

e) EVSE input power: $P_{INPUT} = \frac{1}{T}\int_0^T i_{in}(t) \times v_{in}(t)dt$

f) EVSE output power: $P_{OUTPUT} = \frac{1}{T}\int_0^T i_{out}(t) \times v_{out}(t)dt$

3) Repeat for all loading conditions in Table 3 that are less than or equal to the full current output capability of the UUT, in sequence from Loading Condition 2 to Loading Condition 4.

4) Measurements at subsequent loading conditions shall be conducted under the 5-minute stability guidelines in Section 6.4.D)1), above.

Table 3: Loading Conditions for UUT

	Test Condition Current (A)	Example for 500 kW capable UUT	Example for 350 kW capable UUT	Example for 50 kW capable UUT
Loading Condition 1	10 kW ± 0.2 kW and 350 V ± 7 V	10 kW	10 kW	10 kW
Loading Condition 2	30 kW ± 0.6 kW and 350 V ± 7 V	30 kW	30 kW	30 kW
Loading Condition 3	50 kW ± 1 kW and 350 V ± 7 V	50 kW	50 kW	50 kW
Loading Condition 4	150 kW ± 3 kW and 400 V ± 8 V	150 kW	150 kW	Do not test
Loading Condition 5	350 kW ± 7 kW and 900 V ± 18 V	350 kW	350 kW	Do not test
Loading Condition 6	Max Available Power Output (determined in Section 6.4.B), above) ± 2% and Voltage= Pout / 0.4 A + 300 V ± 2%.	500 kW	Tested above	Tested above

6.5 Full Network Connectivity Testing

A) For products with data/networking capabilities, the presence of Full Network Connectivity shall be determined by testing the UUT for network activity in Partial On Mode according to Section 6.7.5.2 Method 1 of Consumer Electronics Association (CEA) 2037-A, Determination of Television Set Power Consumption, with the following guidance:

1) The UUT shall be connected to a network per Section 5.1.B)2) of this test method prior to the test; and

2) The UUT shall be placed into Partial On Mode in place of Standby-active, Low Mode.